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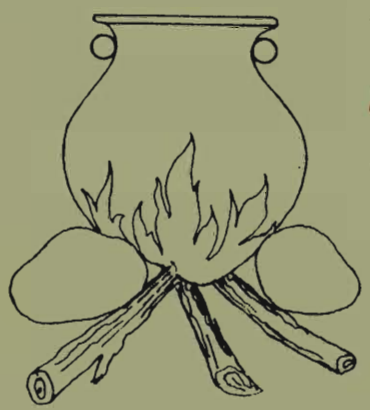
IMPROVED COOKSTOVES IN THE SAHEL

REPORT ON THE THERMAL CHARACTERISTICS OF IMPROVED WOOD COOKSTOVES IN THE SAHEL



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INTRODUCTION

The present report recommends the adoption of a model of improved cookstove in Banco to replace the three-stone method of cooking in Sahel countries.

Improvements are possible in fuelwood efficiency depending on circumstances and people involved: chimneys, metal sheets with round holes to hold pots, doors, grills, etc.

The adoption of an improved cookstove represents an enormous programme on the level of the Sahel, numbering thousands of stoves to be built. The programme can be developed through diverse organisations but above all through local craftsmen and industries.

It is strongly recommended that the programme be monitored with care because it can definitely induce, if well executed, energy savings and an improvement in the lives of thousands of Sahelians.

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REPORT ON IMPROVED STOVES IN THE SAHEL

OUTLINE

PART 1 - OBJECTIVES

The terms of reference of the ROGGEMAN mission to the Sahel in October 1980 were:

(A) to measure the thermal characteristics, temperatures, consumption and yields of improved, wood-fired cookstoves;

(B) to give a detailed description of stove construction and dimensions;

(C) to make recommendations on possible improvements and select the most efficient types.

The report was therefore orientated as far as possible towards quantified studies and a rather technical approach was adopted so that this report might serve as a working basis for possible further studies.

Previous studies

Proposals for improved stoves have been made mainly during the few years since the energy crisis arose.

A number of reports have already been drawn up, followed by various missions and studies. We read these reports and as far as possible met the authors. They constitute a valuable body of knowledge. And even if the results of conclusions are sometimes rather vague and occasionally divergent, on the whole they complement one another very well. We have taken them into consideration in the present study and part of our recommendations and conclusions confirm the work already done.

Cooking has been done since time immemorial in the Sahel by placing the pots on three stones and lighting a fire under the pot between the stones. This is a practical method and the fire is easily controlled and prepared. But, population is increasing, wood is becoming scarce, drought is causing the desert to advance and lifestyles are evolving .... Consequently, efforts are being made to develop improved stoves.

PART 2 - METHOD

I elaborate here on this point because it is important in assessing the credibility of the study. A distinction must be made between experimental methods used in the exact sciences (physics, chemistry, heat physics etc.) and the methods of observation used in the social and economic sciences (market and consumer studies, etc.).

A. OBSERVATION METHOD

What are we trying to find out?

- The characteristics of improved stoves as found in the user's home;
- The energy savings made by the users in their daily life.

It is clear that what is of most interest in this type of study is what happens in reality under conditions of use in the field and not what might happen or what might be done. It involves observation which is as objective as possible. What is sought is to take the social milieu, as it exists in daily living, in the process of using the product, without influencing it in any way.

The method consists in carefully selecting population samples and in each of these samples conducting short ad hoc measurements on the largest possible number of users. The quality of the results depends on the proper choice of the samples and on having a sufficiently large number of measurements to be statistically significant.

SELECTION OF POPULATION SAMPLES

Six population samples were selected:

- three in Senegal
- three in Upper Volta.

1. IN SENEGAL

First sample

A so-called "reference" population sample. We chose the village of Maik Diop which had never been involved in any assistance programme and which was totally unaware of the improved stoves. However, this village had sociological and economic features which were characteristic of the region. These features will be set forth in this report.

Second sample

Population sample using improved stoves of the "Banco without chimney" type (BANCO: a clay and sand mixture of the cobwork type). This population was situated in a village 20 km from the previous one with the same type of population and ecological, social and economic environment. They eat the same dish, LAX. This series of measurements was also made at the same time of the year.

Third sample

Population sample using improved stoves of the "Banco with chimney" type, situated at 40 km from the reference village. The conditions of usage and the environment are the same as in the previous samples except for the following differences:

- wood supplies seemed to be somewhat better in this area. The greater availability of wood will have to be counted as a factor encouraging consumption;
- it was necessary to take samples in several villages instead of one because there were not enough improved stoves in any single village.

2. IN UPPER VOLTA

First sample

So-called "reference" population sample, using the three stones in a small urban district of OUAGADOUGOU (district of SOGONA, a non-divided district of SOGONA). This type of family eats the traditional dishes of the region: rice sauce and TO sauce (TO: crushed millet with sauce).

Second sample

Also a reference population sample, using the three stones in the same way as for the previous population except that here it is a better-off district of Ouagadougou. Apart from the income, the cooking methods and lifestyle are the same.

Third sample

Population sample using the improved stove in cement, of the NOUNA type (German mission project). This involves a better-off group as in the previous case.

Fourth sample

Population sample using the improved stoves in cement, of the KAYA type (USAID project) and AIDR (Belgian mission). Here again the situations were quite comparable with the previous two populations.

Comparison of the results in each of the countries will make it possible to see what modifications and improvements have been brought about by the introduction of the improved stoves. The method chosen is that used in market studies for consumer goods. It can have a disadvantage. In effect the comparison is not made between identical families but between similar families. Care must be taken to ensure that the families compared are really comparable. It is important to choose the samples properly. We have done it carefully and believe we have good samples. It has a second disadvantage - that it has been conducted on a relatively small population sample (150-200 families) while a market study requires a larger number of observations (several hundred observations with one team of researchers). This is a statistical method, i.e. the greater the number the more significant are the quantities and averages.

But even if the results might be modified through a more elaborate study it is likely that the orders of magnitude found would be in the same sense and of the same order of magnitude as in the present survey. However, approximately 200 families were visited and analysed and between 100 and 150 of them were retained for the quantitative study. The details will be given in the present report. Even this number is sufficient to determine orders of magnitude with certainty. Consequently we believe that a satisfactory level of significance must be attached to the results described below.

It is possible that a study on 500 families with several reference samples and more people using improved stoves would give different results. For example, 30 per cent instead of 20 per cent improvement might be found. But it is almost impossible for radically different results to be found, such as 50 per cent instead of 10 per cent improvement. Let us say that the study could be inaccurate by approximately ± 10-20 per cent but not 30-50 per cent.

B. THE EXPERIMENTAL METHOD

What do we want to find out?

- The theoretical possibilities of each of the stove models when they are used to the best of their potential.

For this, tests are prepared which can be conducted on all the types of stove to be compared.

EXPERIMENTS AT THE HOMES OF THE USERS

A study is being conducted by Miss Marguerite ZONGO. We had a long discussion and tested the execution of this experiment in the field. She seems correct from the point of view of method and we believe the results will be significant. A limited sample of families has been chosen. They are asked to use a three-stone fireplace for a sufficiently long time - a month or a week. Then they are asked to use the improved stove for

the following week or month. A comparison is then made of the results. This experiment has the advantage of covering a sufficiently long period under identical conditions.

This investigation can be properly carried out but the following difficulty could arise: the user must be previously familiar with the method and the aim desired; this assumes a certain standard of education and participation in the research. The findings will therefore be closer to those one expects to get as compared to work conducted in a non-experimental milieu. Hence, the results will be similar to those of the observation method but slightly better.

EXPERIMENTS IN A TEST CENTRE

This involves preparing, at a test centre or laboratory, a comparative test which would be strictly the same for all the stoves tested.

First test - recommended

Boil water from the ambient temperature to 100°C and measure the quantity of wood used.

Second test

Stationary state test: the aim is to maintain a stove at a state slightly below boiling point for a given time, one to two hours, and measure the weight of wood used.

These tests are more difficult to carry out than appears at first glance either because the lots of wood are not identical or because one fire starts burning more rapidly than another. It would therefore be necessary to carry out the same test some ten times on each stove to establish an average performance.

These tests should be carried out "ceteris paribus": same quantity of water, same type of pot, same type of wood, same method of lighting the fire, etc. This method was used in preparing this report but not a sufficient number of times to be significant. Mr. Madon du Cerer in Dakar is in the process of undertaking a programme in this sense. We discussed it and I believe that the method he plans to use is valid.

Other studies are being or have been carried out. They seem to belong to this experimental type. An attempt is made to measure theoretically optimum capacities, with strict control of combustion. Mention was made several times of the figure of 50 per cent improvement. Without wishing to prejudge, it seems that these would be maximum figures obtained under ideal experimental conditions. The authors do not seem to claim that these are figures which can be obtained in the field.

I conducted only some 15 measurements of wood fires, with the time test for bringing to boiling point. I found a vague correlation in my results but do not think they are sufficiently valid to be reported.

PART 3 - THE SOCIAL CONTEXT

The improved stoves will replace the "three stones" progressively only if they are an African product conceived and made for and by Africans.

Consequently, study and understanding of the social context in which this new technology is to develop is essential. That is also why we began our study with the largest possible number of visits to African families who were users.

The spontaneous and warm hospitality of the families we met in the villages and towns visited in Senegal and Upper Volta very frequently gave occasion for extremely pertinent discussions with the users.

Everyone gave his opinion. As a matter of politeness the improved stoves were never criticised. Sometimes one had to guess the complaints. The women laughed to see the "experts" suddenly becoming interested in their cooking. The men got involved and gave their opinion. The children gathered around. Whenever there was time, we went to sit with the elder who regaled us with the village legends. Improved stoves do not concern him! Laughing, entrancing AFRICA!

A considerable number of the comments gathered in the compounds, towns and villages are given here and there in this report and acknowledgement is due to their authors.

A. THE AFRICAN FAMILY

In the areas visited we met families in urban areas, OUAGADOUGOU, DAKAR and THIES, and families in the bush 10 km to 50 km from THIES and LOUGA.

When individual cases are examined there is great diversity of family types with regard to size, organisation and way of life. However, through this human diversity one finds a number of major characteristics which may be considered as basic data for our study, particularly:

- family size:

  Whenever we asked a family how many people they had for meals everybody laughed. In practice the African family is extensible and flexible. The number of people can vary enormously from one meal to another. Consequently any measurement of wood consumption had to be done in consideration of the number of people.

  However, there is no doubt that from the moment when a fire is made for a family meal, the fact that there are one or more additional people does not change wood consumption very much. A large family (15 to 20 persons) will consume proportionately much less wood than a small

family of four to six persons; hence the importance of taking careful account of the family factor in the assessments.

However, families of 10 people are most frequent and the majority of families approach this figure (between 8 and 12 persons - no doubt representing two-thirds of the families). In practice this means that from a broad population sample the family variations are less than would appear at first sight.

B. HABITAT

The compound is a square which varies in size, say 20 to 30 metres square, surrounded by a fence of 1.50 to 2 metres high, within which the family lives. Normally there are three or four huts, and the yard fowl (hens, guinea fowl, pigeons, etc. and small mammals).

Cooking is done in a separate hut. The stove may be inside or outside the hut. When it is a straw hut the smoke causes no problem because it escapes easily. When it is a solid hut, mostly dried mud or dried mud bricks, provision must be made for the evacuation of the smoke. The waterproofing of the roof is fairly good because the rain could otherwise damage the stove and interfere with the cooking.

The effect of the wind may also be very important at certain times of the year. But because the fire is inside the compound it is normally protected by the surrounding walls and fences.

During the survey the anemometer for measuring air movement was never used because we never met with any significant wind.

In the towns, similar conditions are found because the same habits and ways of life have been transferred from the country to the town, except that in town the compounds are smaller and the dwellings larger. A house of several rooms gradually replaces the huts. Because of the heat, cooking is always kept apart from the rest of the dwelling.

C. FOOD AND ITS PREPARATION

The types of dishes prepared vary, of course, from one area to another and one season to another. They vary as much in relation to ways and customs as to what may be found to eat in each season. As in any part of the world, however, some basic dishes are found which constitute the local speciality.

At the time of the mission, i.e. in October and November, the dishes found were as follows:

- Lax (pronounced "lar", "r" guttural).

This is millet crushed to a fine flour, mixed with milk and offered in a calabash. The calabash is placed in the centre and each one serves himself in a plate with his fingers.

We tasted a little everywhere. The quality is rather variable. When the millet is good, the flour well made and the milk fresh, the dish is quite pleasant. On the other hand, it can happen that the flour may be a bit stale and the milk not fresh and this reduces the quality of the dish. The cooking of this dish is rather rapid because there is little preparation apart from the cooking of the millet. It is necessary therefore to combine the ingredients carefully every time lax is prepared.

- Couscous

This is a dish based on crushed millet mixed with soup and vegetables. This dish requires much more preparation because there are three components to be cooked and prepared separately.

- TO

This dish is the most common at this time of year in the OUAGADOUGOU area. A sauce is prepared which can vary greatly from one meal to another. It may include herbs and meat. Vegetables may also be prepared if necessary. The whole makes a dish which is rather complicated and slow to prepare. The TO has to be energetically stirred for a long time during cooking. It is a dish which consumes a great deal of wood.

- Hot water

Hot water is needed very often for the preparation of dishes, for dish washing, for washing, for hot drinks (tea) etc. This means that an effort is always made to use the remains of the fire. This hot water requires little time and little heat energy. The water is heated, for example, with what remains of the fire after the meal.

D. WOOD AND ITS UTILISATION

Meals are prepared by the women and the daughters of the house. In families where there are several women cooking is done one day by one woman, the next by another and each on her own fire with her own utensils and in her hut. This aspect must be considered when an attempt is made to find out whether the improved stoves are used because in this case they are used at best one day out of two or three. However, on the whole the proportion of families where there are several women is rather small in the populations under consideration.

The fire is normally used in the morning, in the evening before bedtime and for the two main meals, one around midday and the other in the evening between six and eight p.m. Wood has to be either collected or purchased. People often go off early into the bush and bring home what they find.

Whenever possible we studied the type of wood used. The sources vary according to the village. In one village, for example, we found mainly "rogne" (a very fibrous wood) which burns rapidly but is light and easy to carry. The most common types are hard woods such as the buttertree ("karite").

When there is nothing else, sprigs and small deadwood from trees and bushes are burned. In the areas visited at the time in question there were no really serious problems of supply in the bush. Around THIES the wood was indeed relatively abundant but, conversely, in OUAGA wood is expensive.

In town, wood is purchased according to financial means. We stopped with some wood merchants, talked with several of them and weighed the heap of wood they were selling. In OUAGADOUGOU wood is purchased by the barrow load at from FCFA 50 (600 grammes is a typical weight) to FCFA 100 (about 1,200 grammes). This makes wood very expensive by the kilo. The barrow loads are not weighed but estimated. Then there must be somebody to break up the wood and split it to the size required as meal times come around. With this system it is quite clear that the financial situation of the family has an enormous influence on the quantity of wood consumed. This is all the more true when, if the family is reasonably comfortable or large, it is not the mother of the family who does the cooking. Then it is the daughters, who are likely to be less conscious of the cost of wood than the mother herself would be.

Once split, the wood is put into the stove and lit with a little paper or grass and sprigs and a match.

The wood is burned with care. The speed of combustion and control of operation also constitute a very important factor in the total consumption of wood, from which arises the importance of being able to have a clear view of the fire; this is the case with the "three stone" fire, which permits good control. It is not the case with some of the improved stoves and there is a tendency to use more wood than is necessary for fear that the fire might go out without being noticed.

In areas where the soil is sandy, which is fairly common, the women put out the fire by putting sand on the cinders. But this is not always the case and not always possible. Then they merely separate the larger pieces of wood and allow the remaining cinders to burn out.

E. EFFECT OF IMPROVED STOVES ON THE AFRICAN WAY OF LIFE

WHAT IS BEING SOUGHT?

An effort is being made to innovate and change the type of stove. This is bound to have an effect on the equilibrium of family life, the use of daily time, finances and perhaps methods of cooking, etc. And this in turn will influence the type of cooking utensils and many other things in addition.

1. THE ENERGY-SAVING ASPECT

This advantage is the one which is always first mentioned both by the families and by the promoters of improved stoves. Opinion is unanimous: "Much less wood is consumed, it is very good, there is a saving of energy". But the admirable unanimity around this observation is quickly shown to be a façade for many other truths which are perceived more or less consciously by everybody. Everything happens as if "energy saving" was a relief, a possibility for success, a fashion to which everybody pays homage and which is announced loudly and clearly to show that the general trend is being followed. There has indeed been energy saving in a number of cases but not in all. And this has not reduced everybody's enthusiasm for the stoves "which save energy", so there is something else ...

2. THE COMFORT ASPECT

The majority of users have themselves emphasized the comfort aspect. The improved stoves are cleaner. They make it possible to evacuate the smoke when it is annoying, the dishes remain better in position, the children do not run the risk of getting burned by falling into the fire, fire hazards are reduced etc. Briefly, there is improvement.

This occurs in the context of an evolution in lifestyles towards more comfort and more modernisation. This is also well understood. It may even be said that even if the improved stove did not give any energy saving it would be appreciated and desired for what it represents in improving daily living.

3. THE SOCIOLOGICAL ASPECT

The improved stove forms part of a movement towards urbanisation and solid house construction. It is still possible to transport the three-stone fire from the country to the town but when solid houses which are well closed and clean are desired it is necessary to use the improved stove to complete this new way of life.

4. INFLUENCE ON MENTALITY

It is easy to appreciate the advantages which improved stoves have on daily living but their influence on mentality is not always fully appreciated.

Cooking a meal is much more than a simple mechanical and technical activity. It occupies a large place in daily living. The fire has a very important symbolic meaning for the family. The words "hearth and home" (and much more literally in French, the word "foyer" = fire or HOME have become synonymous with family life; sociologists have paid considerable attention to the importance of the fire and the meal in the life of a people.

The whole ritual surrounding the wood, from its collection until meal time occupies a large place in the daily life of the African family. This must be well grasped if one is to understand the repercussions and importance of any change in this ritual for African living. The significance of this must be understood in order to see that in changing these fires something which is at the very source of the family is affected.

Consequently it is essential to see here that a matter of much more fundamental sociological importance is affected than merely a saving of energy.

With the improved stove we transfer from ritual to function.

Cooking becomes functional. The fire is no longer visible, care is taken particularly to reduce wood consumption and cooking time. From a ritual approach we arrive at a functional approach of cooking ... and of life.

This evolution will not fail to affect mentalities in the direction of functionalism, particularly when it results in numerous small changes of detail in the material life of the family.

It is not possible here to elaborate further on this aspect of the improved stove project. It is however very important and deserves further study.

F. INFORMATION AND TRAINING FOR USERS

Community information and training structures will be necessary for stove users. It is becoming clear that it is not possible to launch this project of improved stoves without introducing psychological and social factors; these imply, among other things, training for users, and this does not seem to have been systematically undertaken up to the present. Both women and men are involved but women first of all because they are the users.

But it is often the man who gets the information and makes the decision concerning the improved stoves. He will also make the decision concerning the various initiatives necessary to ensure that everything works out properly.

This needs to be examined and competent staff structures established. It would be desirable to prepare group training in relation to improved stoves, around certain major aspects such as:

PUBLICITY for improved stoves:

It is desirable to make a radical change from the way in which they are presented at present. Improved stoves are not automatically a means of saving energy. They can become so if one knows how to use them properly.

The users themselves have clearly seen the comfort and modernisation aspects of these stoves compared with the three stones. They will often be very receptive to this argument, perhaps more than that of energy saving. For many of them energy saving is a valid economic pretext but comfort and modernisation are the real advantages which they personally feel when buying an improved stove. Publicity should therefore be around the following themes:

- "It can save energy";

- "It is modern and practical".

TRAINING:

Training can be rather brief. However, it is necessary to find a formula by which the purchase or construction of a stove goes hand-in-hand with a training session. For example, the instructress might spend half a day with the women and give a cooking demonstration. Meetings with women might be held on an afternoon at a demonstration centre where a fire would be lit and the method of use explained. This aspect should be examined by sociological specialists.

G. TRAINING STRUCTURES FOR USERS

The improved stoves are new products which are not as easy to use as it might seem and observations in the field have shown that the stoves are far from being used to the best of their potential.

It is clear that the education of the users is essential. This has often not been done at all. On the face of it it seems strange to distribute a product without disseminating instructions for its use. Consequently, it is essential to plan, in a framework which remains to be defined, for sessions, classes, etc. during which the users would be made familiar with this new product. The various centres, meeting rooms, etc. which exist will be very useful in this work.

It will be necessary therefore to co-ordinate programmes for distributing the improved stoves with a parallel programme for spreading the necessary information.

PART 4 - THE ECONOMIC CONTEXT

A. MARKET DEVELOPMENT

In using the same approach for improved stoves as that used in any undertaking or organisation of industrial production, we can see that we are on the threshold of a large market and one can ask how it is going to develop.

The section of this report devoted to technology shows that this market evolves in three stages:

1 - the stage at which everybody has the three stones;

2 - the appearance of the new model, 1978-82, and its development;

3 - mass distribution, 1982-90.

This is the "explosive" type of market. That means that first of all there will be a rather long running-in stage during which supplies exceed demand. This is the present phase. It means that there will be more stoves than customers.

In the second stage, the market will explode: demand will be higher than capacity to supply. The number of clients will increase at an accelerating rate. This explosive increase occurs in the majority of markets. Normally it takes two to three years to reach this stage fully.

At this stage it is necessary to be active both from the technological point of view as from the viewpoint of the technical advisory structures in production and consumer training. If it may be assumed that this opening will begin towards 1982 we can see that between 1982 and 1986 it will be necessary to be ready to meet a very considerable demand. It may be estimated that in the intensive development phase of the market several hundred thousand stoves will have to be made every year. It is to be hoped that the various social, craftmanship and financial structures will be ready to respond to this market.

An understanding of this growth phenomenon special to household goods is essential because it dictates the method to be followed and the organisation to be planned in this field during the coming five to ten years.

B. PRODUCTION AND DISTRIBUTION STRUCTURES

1. THE GOVERNMENT ORGANISATIONS IN THE SAHEL

Various government bodies are interested in the project of improved stoves, particularly institutions concerning the situation of women, and the Ministry of the Environment is interested because it involves the use of wood.

These bodies serve as advisers and guides in relation to the project of improved stoves. However, it is clear that they cannot play an active direct part in the carrying out of this very special project. Of course, their role is not to construct the improved stoves or have them constructed but to see that this project is correctly implemented and integrated in a broader framework.

They make the decision which will give to each of the structures mentioned below the appropriate place and weight.

2. THE INTERNATIONAL, STATE AND PRIVATE BODIES

A number of missions operating in the context of the Sahel or in a national context are undertaking special projects for promotion and distribution as well as technical research in relation to these stoves. Up to now their activities have been the most specific and are the ones which are commented upon in this study. These bodies can and do have an excellent influence in beginning the process of innovation and launching manufacture.

However, production capacity concerns from some hundreds to some thousands of stoves or even to tens of thousands. When one speaks of a market involving hundreds of thousands or even millions of improved stoves it is clear that these bodies have neither the vocation nor the necessary industrial structures for such a production level. It will therefore be necessary to supplement them with more appropriate structures.

The action of these bodies is therefore vital in relation to the development of models and their manufacture in sufficient quantities to enable them to be tested.

3. THE INDUSTRIAL COMPANIES AND CRAFTSMEN

When basic technological decisions have been made and the main types of stoves selected, it will be necessary to distribute them rapidly. For this purpose the best means would be to use African craftsmen, who are numerous and scattered around the countries. In the case of improved stove models which are free of charge and can be installed by the users themselves, the donor bodies mentioned above could continue their activity. For stoves where a certain amount of knowledge and money is necessary the activity of craftsmen and small manufacturers is essential. Training of craftsmen could be undertaken either by the above-mentioned bodies or by apprenticeship centres of the type of that in OUAGADOUGOU which is perfectly suited to this type of trade. It will remain to determine whether this constitutes a separate type of craftsmanship. This would no doubt be the case because there will be enough to occupy a craftsman and his team full-time. In this type of activity, vocational specialisation is always very advantageous from the point of view of quality and reproduction of product. This transition to production by craftsmen has not yet been undertaken and it would be desirable to deal with it as rapidly as possible because it is the essential link in this project of improved stoves. In addition, it involves a

kind of manufacture which would have a beneficial effect on the economic fabric of the Sahel because it would contribute to the encouragement of craftsmen and small local businesses(1).

4. CREATION IN THE SAHEL OF AN EVALUATION AND TECHNOLOGICAL CONTROL CENTRE FOR IMPROVED STOVES

Because of the magnitude of the future distribution of these stoves throughout the Sahel it seems absolutely essential to have in the SAHEL itself at least a small unit which would be able to control and provide technical recommendations for the proper implementation of the project. The general impression which arises for all the present projects is that of a great deal of goodwill but a rather large amount of amateurism in relation to technical knowledge.

This control and evaluation unit should have at least one person at engineer level. But this person would not devote his whole time to the project and two or three technicians could be appointed to the unit on a full time basis. They should all be on the spot in the SAHEL.

As for any control and testing body worthy of the name, this unit should be attached to a university or some other organisation independent of the financing sources of projects. These suggestions are based on the quality control and standardization services in the various industrial sectors (for example: the AFNOR standardization service in France, DIN in Germany, or the I.S.A. in the United States) as well as the various technical sectors financed by inter-professional bodies independent of the manufacturers (example: C.E.B.T.P. - experimental centre for building and public works; L.C.I.E. - centre for the electrical industries, etc.).

The value of this type of independent organism is clear in relation to all manufacturers of a given type of product. We believe it would be accepted by the different distribution projects for stoves and also by the various interested bodies and ministries and the craftsmen.

We take the liberty of emphasizing the fact that in the absence of any independent technical authority it will be impossible to take concrete action in relation to the quality and performance of the proposed products.

The functions of this unit would be as follows:

(a) the establishment of simple but clear standards for the selection of materials and construction procedures;

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(1) The craftsmen also constitute a commercial structure which is very suitable for distributing the stoves because they are in contact with the people and would have an interest in the sale of stoves. They would probably be the best promoters of these products throughout the SAHEL.

(b) the establishment of simple but precise procedures for control of improved stove performance, these procedures being the same for everybody;

(c) organising regular inspecting campaigns in the field to verify compliance with the standards and development of performance;

(d) evaluation, by the same standards and procedures, of any new type of improved stove which might be proposed for distribution.

5. TESTING AND DEMONSTRATION CENTRES FOR IMPROVED STOVES

One already exists at the University of DAKAR. There is also the CERER centre testing all types of stoves in SENEGAL grouped together for the study of the laboratory performance of these stoves.

There is also one in OUAGADOUGOU: models on display by the German forestry mission and another by the Belgian AIDR mission and a third at KAYA. Lastly some stoves of different experimental models have been built at the C.N.P.A.R. (Craftsmen Centre). Each of these centres tests its own improved stoves and it would be the responsibility of the evaluation and control unit for improved stoves to carry out the comparative studies not yet made between these various centres.

C. FOLLOW-UP

It is important to have follow-up on the part of all those who hope to promote the improved stoves. This follow-up should be conducted in relation to the quality of the product, its durability etc. (see technical support structures).

The follow-up should also be done at community level to see whether the stoves are being properly used, whether they are spoken well of (and the bad opinions that are held without being voiced) so as to know and understand whether neighbours can be influenced by the existing stoves. It is also desirable to discover the motivations which attracted the users.

PART 5

MODELS OF IMPROVED STOVES AND DISTRIBUTION PROGRAMMES

The stove models and the distribution programmes do not always coincide. Thus the CERER in SENEGAL has two models while the USAID and AIDR programmes use the same model in cement, which, incidentally, is very close to the German "NOUNA" model.

There are therefore two models for one programme in SENEGAL and one model for three programmes in UPPER VOLTA.

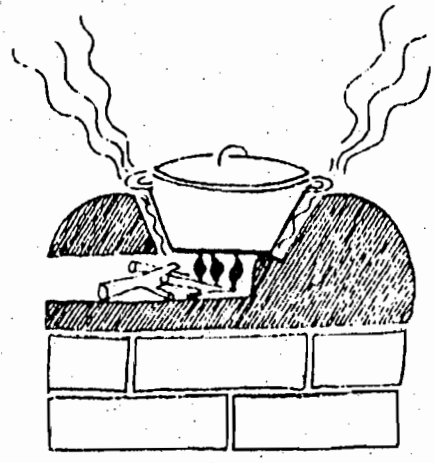
THE MODELS

What interests us in this technical section is the models of stoves and not the programmes.

All told, there are three models of stoves:

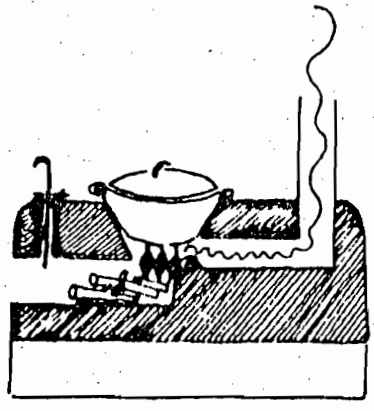
A. THE "BANCO" MODEL WITHOUT CHIMNEY AND WITH ONE HOLE

See sketch below:



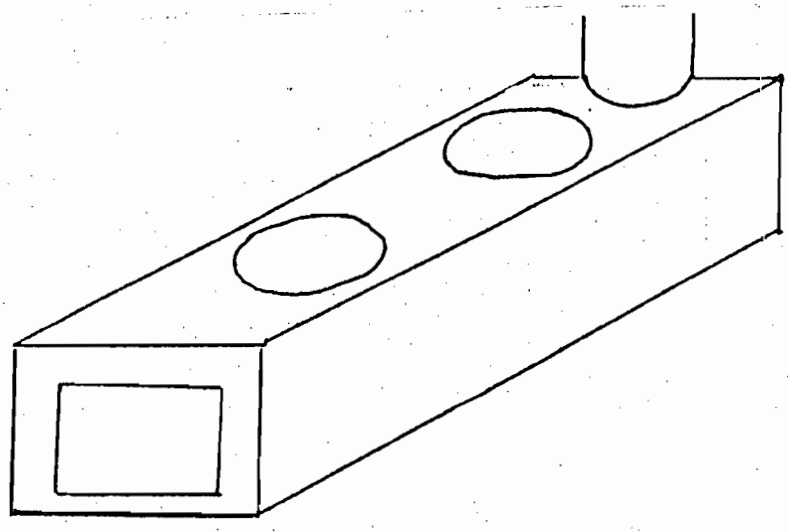
B. THE "BANCO" MODEL WITH CHIMNEY AND TWO OR THREE HOLES

See sketch below:



C. THE LOW MODEL IN CEMENT WITH CHIMNEY AND TWO OR THREE HOLES

See sketch below:



THE PROGRAMMES

In the development, execution and smooth operation of the programmes, it is the organisational structures which must be considered.

We have:

A. IN SENEGAL

The CERER managed by Mr. Gérard MADON.

The programme began about a year ago and the publicity for the stoves around the beginning of the present year. Approximately 300 stoves are in operation; the BANCO model without chimney was developed by the American Peace Corps in co-operation with the CERER.

The CERER operates as the centre for publicity, team training and testing of approved stoves, and it has a number of improved stoves on the spot for testing. The fact that there is a single organisation seems to be an enormous advantage for the proper functioning of the programme.

B. IN UPPER VOLTA

1. THE PROGRAMME OF THE GERMAN FORESTRY MISSION

with the Ministry of the Environment and Tourism.

This programme is led by Mrs. KEMPERS. It began several years ago. However, the intensive publicity seems to have begun approximately 6 to 12 months ago. There are approximately 300 models of this type built so far. The German mission has demonstration samples of this stove.

2. THE USAID PROGRAMME OF MR. JONATHAN HOOPER IN KAYA

This programme is also rather recent as far as concerns intensive publicity. The model differs from the previous one particularly in construction, the dimensions and type of materials used being very similar. There are approximately 200 in operation.

3. THE AIDR PROGRAMME

in co-operation with the Ministry for Women's Affairs. Again, the organisers are very active.

This programme uses the KAYA type stove. There are approximately 300 in operation.

Although the object of the mission did not cover an examination of programmes and institutions, it seems that the three bodies operating in UPPER VOLTA are rather similar although the AIDR seems to place emphasis more on follow-up in manufacturing and contact with the customers.

I did not have time to visit KAYA.

The multiplicity of programmes in UPPER VOLTA did not seem to us to be a bad thing in itself. However, it seems to have stimulated competition more in relation to the number of stoves built than to the technological improvements (since they all selected the same model) and also in the training of users. In this connection a corrective action seems essential to avoid the unrestricted distribution of an unsuitable model badly presented to the public. This might well cause failure and a turning away of the public who would then have to be coaxed for a long time before trying again.

PART 6

RESULTS OF THE CONSUMER STUDY

3 STONES AT ZOGANA

OUAGADOUGOU

(A POOR QUARTER NOT DIVIDED UP)

FAMILIES	QUANTITY OF WOOD BURNED	TYPE OF WOOD	FAMILY SIZE
No. 1	1.8 in kg	acacia and bushes	
No. 2	6.8	"cira" (dialect)	
No. 3	2.4	acacias	
No. 4	2.6	acacias	
No. 5	1.2	hard redwood	7 p
No. 6	0.8	hard redwood	8 p
No. 7			
No. 8	no measurement		
No. 9	no measurement		
No. 10	no measurement		
No. 11	3.2	acacias	
No. 12	4.4		
No. 13	2.0	(yam + rice)	8 p
No. 14	4.8	acacias	
No. 15	3.4		
No. 16	0.7	1 heap of wood purchased at CFA 50 before the meal - 1.5 kg approximately	10 p
No. 17	0.8	1 heap of wood purchased at CFA 25, all burnt	5 p
TOTAL	35.0 kg		
AVERAGE	3 kg per family and per meal and approximately 8 persons per family		

WOOD: [illegible]ly hard firewood split and purchased from the merchant.
Food: TO sauce or rice sauce in all families (except No. 13).

A.I.D.R. KAYA STOVES IN OUAGADOUGOU

(divided district)

FAMILIES WITH AVERAGE INCOMES AND COMFORTABLE

FAMILIES	QUANTITY OF WOOD BURNED in kg	TYPE OF WOOD	MEAL PREPARED	FAMILY SIZE	COMMENTS
No. 1	2.2	acacia branches	round rice	10 p	morning, 3 stones
No. 2	5.0	acacia	rice sauce + TO sauce	10 p	
No. 3	2.3	buttertree	TO sauce	16 p	strong fire (with protective metal disc)
No. 4	4.5	various	rice sauce TO sauce	6 p	permanent hot water - unused holes not closed
No. 5	2.6	various branches	rice sauce	7 p	
No. 6	5.3	acacia	TO sauce	20 p	
No. 7	5.8	various	TO sauce + soup	15 p	2 AIDR ovens - the woman of the house has returned from Mecca and therefore there is a big meal
No. 8	3.0	acacia	TO souce	11 p	
No. 9	2.4	various	rice sauce	14 p	2 AIDR stoves
No. 10	3.6	various	TO + meat comb-potatoes	6 p	
No. 11	5.3	various	TO sauce	14 p	
No. 12	7.0	various branches	TO sauce + lax	15 p	the fire burning outside
No. 13	?			?	Madagascar fire, AIDR not used
No. 14	4.6	various	rice sauce	6 p	broken chimney fire damaged

A.I.D.R. KAYA STOVES IN OUAGADOUGOU
Continued

FAMILIES	QUANTITY OF WOOD BURNED in kg	TYPE OF WOOD	MEAL PREPARED	FAMILY SIZE	COMMENTS
No. 15	4.0	various	TO sauce	9 p	
No. 16	4.5	various	TO sauce	8 p	very rational usage - third hole for water the fire is stopped ½ hour before the end of the cooking
No. 17	2.8	various	TO sauce + soup	10 p	strong fire
No. 18	4.2	various	TO sauce + water	20 p	very strong fire - 2 holes
No. 19	4.5	various	TO sauce + rice + water	15 p	
No. 20	6.4	various	TO sauce hot water + soup	8 p	finished burning the wood in the evening (tea?)
No. 21	3.2	various	TO sauce hot water	6 p	only stove with door
TOTAL	83.70 kg			226 persons	
Average	4.0 kg per family per meal			11 persons per family	

FINDINGS OF THE STUDY OF WOOD CONSUMPTION IN OUAGADOUGOU, UPPER VOLTA

FAMILIES WITH AVERAGE INCOMES

NOUNA TYPE STOVE

FAMILIES	TYPE OF STOVE	TYPE OF WOOD	WEIGHT BEFORE in kg	WEIGHT AFTER in kg	QUANTITY BURNED in kg	FAMILY SIZE	DISH PREPARED	COMMENTS
No. 1	N 2	BUTTERTREE	7.4	6.2	1.2	6 p	YAM	
No. 2	N 3	ACACIAS	5.5	0.0	5.5	7 p	TO	
No. 3	K							No wood stored, purchased before the meal, also metal stove. Morning: butane gas, fire too strong
No. 4	A + 3 p							No wood stored, purchased before the meal. "The holes are too small so the 3 stones are used."
No. 5	N 3	VARIOUS	6.6	3.8	2.8	9 p	TO	Third hole never used (separate fire)
No. 6	Tr.	ACACIAS	18.5	6.6	11.8	11 p	TO	Nouna never used
No. 7	N 3	BUTTERTREE	15.2	10.4	4.8	9 p	Rice sauce	
No. 8		VARIOUS	7.4	4.2	3.2	15 p	Rice sauce	
No. 9	K 2	VARIOUS	9.4	6.0	3.4	9 p	Rice sauce	Fire badly positioned in the stove
No. 10	3 p	TERMINALIA spp.	10.0	6.2	3.8	12 p	TO	"If the woman makes the fire there will be enough wood; if the girls do it it will be rather tight."
No. 11	N 2	KHAYA spp. & MITRAGYNA spp.	21.0	14.2	5.8	7 p	TO	1st time stove used. The wood cinders are recovered
No. 12	K 2							The woman of the house not at home.
No. 13	N 2	BUSHES (BRANCHES)		4.8		13 p	TO	The pot sometimes gets stuck in the hole.
No. 14	N 3	BUTTERTREE	14.0	9.4	4.6	9 p	Couscous + round rice	Strong fire, the lid of the pot in front of the door.
No. 15	N 2						Rice sauce	The woman has gone out.
No. 16	K					5 p	Rice sauce	No measurement, sometimes smokes.

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OUAGADOUGOU (Continued)

FAMILIES	TYPE OF STOVE	TYPE OF WOOD	WEIGHT BEFORE in kg	WEIGHT AFTER in kg	QUANTITY BURNED in kg	FAMILY SIZE	DISH PREPARED	COMMENTS
No. 17	3 p	SMALL WOOD	10.0	5.8	4.2	10 p	Rice sauce	
No. 18	K 2							
No. 19	N 3	VARIOUS						No measurement
No. 20	FM + N 3							FM: Madagascar stove. The FM is used.
No. 21	K + N							Not weighed. N not in order and AIRD working.
No. 22	N + 3 p							Not weighed. There is an N solely for boiling the groundnuts.
No. 23	FM + Tr		12.0	6.4	5.6	12 p	TO sauce	Metal stove of home construction.
No. 24			10.0	6.2	3.8	7 p	TO	
No. 25	Tr. + N 3							"We have 2 N 3 stoves. Today we are using the Madagascar stove." (charcoal)
No. 26	N	HARD FIREWOOD PURCHASED FROM MERCHANT	7.6	5.4	2.2	10 p	Round rice	
No. 27	N + 3 p		4.0	1.6	2.4	9 p	Round rice	Nouna not used; the 3 stone fireplace in use.
No. 28	N + 3 p	" "						Not weighed, 1 sauce on the NOUNA, another sauce on the 3 stones.
No. 29	N	" "						Not weighed. 1 fridge, 1 table, 1 cement floor.
No. 30	N	" "	7.2	5.8	1.4	23 p	TO sauce + hot water	Intermediary disc to allow several pot sizes.
No. 31	N	" "						Not weighed.
No. 32	N	" "						Very strong fire.
No. 33	N	" "			1.2	6 p	Yam, sauce	
No. 34	N	" "						Not weighed.

TOTAL : Of the 18 significant families: 70 kg and 181 persons.

Average: 3.9 kg per family, per meal and 10 persons per family.

Wood size: We have not specified the size because it is ordinary firewood sold in pieces of 20 to 50 cm long and 5 to 10 cm in diameter.

VILLAGE, MAIK DIOP - "CIRCLE"

SENEGAL

FAMILIES	QUANTITY OF WOOD BURNED	TYPE OF WOOD	MEAL PREPARED	FAMILY SIZE	COMMENTS
No. 1	1.0	N'guère	LAX	18 p	
No. 2	2.0	Cade	LAX	8 p	
No. 3	4.0	Cade	RICE	8 p	
No. 4	2.0	Cade	LAX	10 p	
No. 5	4.5	N'guère	LAX	14 p	
No. 6	3.0	Nei	LAX	8 p	
No. 7	1.5	Nenap	LAX	6 p	
No. 8	3.0	Cade	LAX	15 p	Of which 9 children
No. 9					The wood was mixed
No. 10	1.0	Cade	LAX	6 p	
No. 11	1.0	Cade Dakar	RICE	11 p	
No. 12	3.0	Dakar	LAX	8 p	
No. 13	1.5	Sompon	RICE (Tiep)	11 p	
No. 14	4.0	Nenap Cade	LAX	7 p	
No. 15		Sompon			The wood was mixed
TOTAL :	31.5 kg			130 persons	
Average:	2.4 kg per family, per meal.			13 persons per meal.	

Wood names in local dialect (approximate spelling).

N'guère = various branches.

3 STONES: VILLAGE OF PEYCOUCK, SENEGAL

(NEIGHBOURHOOD OF THIES)

FAMILIES	QUANTITY OF WOOD BURNED	FAMILY SIZE	COMMENTS
No. 1	3.6 kg	6 p	
No. 2	2.0 kg	4 p	
No. 3	3.1 kg	5 p	
No. 4	4.4 kg	6 p	
No. 5	1.2 kg	5 p	
TOTAL : 14.3 kg		26 persons	
Average: 2.6 kg per family, per meal		5 persons per meal	

To be compared with the families using the improved stove in the same area.

THE BUSH, VILLAGE OF PEYCOUCK

Neighbourhood of Thies, BANCO WITH CHIMNEY

FAMILY	QUANTITY OF WOOD BURNED	FAMILY SIZE	COMMENTS
No. 1	2.4 kg	6 p	
No. 2	2.5 kg	5 p	
No. 3	0.7 kg	3 p	Stove damaged
No. 4	2.1 kg	2 p	
No. 5	1.0 kg	8 p	
No. 6	3.1 kg	7 p	
No. 7	1.1 kg	4 p	
TOTAL : 12.9 kg		35 persons	
Average: 1.8 kg per family and 5 persons per family			

VILLAGE OF N'DIEYE SEFOUR, 1. BANCO WITHOUT CHIMNEY

FAMILY	QUANTITY OF WOOD BURNED	FAMILY SIZE	COMMENTS
No. 1	2.7 kg	12 p	
No. 2	0.7 kg	2 p	
No. 3	1.1 kg	11 p	
No. 4		7 p	Weight doubtful
No. 5	2.0 kg	4 p	
No. 6			Stove broken; this is not their cooking day
No. 7	0.9 kg	6 p	
No. 8	1.3 kg	12 p	
No. 9	3.2 kg	7 p	
No. 10	1.3 kg	6 p	Meal prepared - rice
No. 11	1.7 kg	8 p	A tripod is placed in the stove
No. 12			No weighing, the fire has been started
No. 13			" " " "
No. 14			" " " "
No. 15			" " " "
No. 16			" " " "
No. 17			" " " "
No. 18			" " " "
TOTAL :	14.9 kg		68 persons
Average:	1.6 kg per family		7 persons per family

MEAL PREPARED: LAX

VILLAGE OF THIOLOM FALL, SENEGAL

BANCO WITHOUT CHIMNEY

FAMILIES	QUANTITY OF WOOD BURNED	FAMILY SIZE	COMMENTS
No. 1	0.4 kg	6 p	Banco with chimney, ring beside
No. 2	1.6 kg	7 p	Banco with chimney
No. 3	6.0 kg	18 p	A baptism
No. 4	1.0 kg	18 p	
No. 5	2.7 kg	9 p	Banco with chimney, there is a fire burning beside
No. 6	3.1		A tripod beside
No. 7-11			The stove is not being used today. (Change-about of women).
TOTAL :	14.8 kg		40 persons
Average:	2.4 kg/family and per meal		9 persons per family

WOOD: sprigs and various wood gathered.

MEAL PREPARED: LAX

Total of 14 stoves of which 6 measured
5 unused so far
1 broken
1 with the village chief

BUSH, NEIGHBOURHOOD OF THIES, BANCO WITH CHIMNEY

VILLAGES OF KUNDANE
FANDENE
KEUR HAR
KEUR DEMBA
DIAME

FAMILIES	QUANTITY OF WOOD BURNED	FAMILY SIZE	COMMENTS
No. 1	2.0 kg	7 p ?	Today the family is small
No. 2	2.3 kg	12 p	
No. 3			It is not being used
No. 4	2.0 kg		For the big wood the 3 stones are used. For the small wood, the banco stove
No. 5	3.5 kg		The 3 stones used (the stove smokes)
No. 6	2.3 kg	12 p	Normally not used
No. 7			Tripod used because the banco stove smokes too much
No. 8	3.6 kg	5 p	1,250 kg of rice cooked
TOTAL : 15.7 kg			
Average: 2.6 kg per family			

WOOD: Small wood

The village spellings might be incorrect.

BANCO STOVES

5 VILLAGES IN THE BUSH

SENEGAL

FAMILIES	QUANTITY OF WOOD BURNED	TYPE OF WOOD	TYPE OF STOVE	COMMENTS
No. 1	12.0 kg	Sprigs	Metal tripod	large meal
No. 2	12.2 kg		Metal tripod	large meal
No. 3	1.9 kg		B.C.	
No. 4	3.1 kg		B.C.	
No. 5	2.3 kg		B.S.	
No. 6	3.6 kg		B.S.	
No. 7	2.4 kg		B.C.	
No. 8	2.5 kg		B.C.	
No. 9	0.7 kg		B.C.	
No. 10	2.0 kg		B.C.	
No. 11	1.0 kg		B.C.	
No. 12	3.1 kg		B.C.	
No. 13	1.1 kg		B.C.	

TOTAL 48 kg

TOTAL B.C. 18 kg for 9 families, or 2 kg per meal with B.C.

S.B. = simple banco without chimney

B.C. = banco with chimney

SUMMARY OF TABLES OF WOOD CONSUMPTION PER FAMILY PER MEAL WITH IMPROVED STOVES

A total of approximately 200 families was visited, of which 140 were listed and 106 (of which 47 in UPPER VOLTA and 59 in SENEGAL) retained for the quantitative study.

TYPE OF STOVE	QUANTITY OF WOOD BURNED (Average)	FAMILY SIZE	NAMES OF LOCALITIES AND AREAS
3 stones	2.6 kg	5 p	PEYCOUCK (SENEGAL)
Tripod	2.4 kg	13 p	MAIK DIOP "
Banco with chimney	2.0 kg	?	5 villages "
Banco without chimney	2.4 kg	9 p	THIOLOM FALL "
Banco with chimney	1.8 kg	5 p	PEYCOUCK "
Banco without chimney	1.6 kg	7 p	N'DIEYE SEFOUR (SENEGAL)
Banco with chimney	2.6 kg	?	5 villages in the THIES and LOUGA Bush
Cement-NOUNA	3.9 kg	10 p	OUAGADOUGOU (UPPER VOLTA)
Cement-Kaya, AIDR	4.0 kg	11 p	OUAGADOUGOU (UPPER VOLTA)
3 stones-Ouaga	3.0 kg		OUAGADOUGOU-ZOGONA (UPPER VOLTA)

CALCULATION OF AVERAGES

3 stones: 2.4 kg to 3.0 kg of wood per meal per family

Banco with chimney: 1.8 kg to 2.6 kg of wood per meal per family, i.e. 15 to 20 per cent less than with the three stones.

Banco without chimney: 1.6 kg to 2.4 kg of wood per meal per family i.e. 20 to 34 per cent less than with the three stones.

An effort was made to make an approximated weighted average, which gave the following result:

BANCO WITH CHIMNEY: 20 per cent savings as compared with the three stones.

BANCO WITHOUT CHIMNEY: 30 per cent savings as compared with the three stones.

CEMENT-OUAGA: no discernible saving

SENEGAL, UPPER VOLTA, CLUB MISSION, October 1980 J.B. ROGGEMAN

DISCUSSION

1. IN SENEGAL

   The results in Senegal are considered significant.

2. IN UPPER-VOLTA

   In OUAGADOUGOU the samples are not comparable due to the disparity of incomes and therefore of lifestyles between the samples. Significant percentages can not be given. It is merely stated that there is no discernible improvement or economy in wood use.

3. Some fifty of the families visited are not listed in the tables, mainly because:

   - the measurement was not valid (doubtful weighting, confusion between the heaps of wood etc.);
   - the families preferred us not to make any measurements at their place (two families);
   - our notes and measurements were badly recorded or recorded ambiguously.

4. Family size variation and variation in local environment prevent any more precise understanding of above results.

   The data are approximate and at best are only estimates. But the trend seems clear.

5. In the analyses, the fires on the three stones and the fires on the circles are considered as equivalent in performance.

6. The families have been mentioned by number to maintain anonymity. However, each of them can be situated for control purposes.

7. Family size: this refers to the number of people present during the meal considered.

8. EXPLANATIONS CONCERNING STOVE TYPES

N = NOUNA: Stove in cement from the German forestry mission.

N 2 = NOUNA with two holes.

N 3 = NOUNA with three holes.

K = KAYA: stove in cement from the USAID programme of Mr. Jonathan HOOPER.

K 2 = KAYA with two holes.

3 p = Traditional cooking on the 3 stones.

Tr. = Metallic tripod surrounded by a fireguard.

A = A.I.D.R.: stove in cement similar to the KAYA stove.

FM = Fourneau malgache = (Madagascar stove).

B.S. = Simple BANCO stove with chimney.

B.C. = BANCO stove with chimney.

9. Considerable disparities appear from one village to another and one family to another. Much caution must be exercised in the analysis.

PART 7

COMMENTS ON RESULTS, AND DISCUSSION

The above results have the advantage of being the first quantified data which is as complete as present resources permit.

A. THE BANCO MODEL WITHOUT CHIMNEY

1. COMMENTS ON THE RESULTS

The improvement recorded with a BANCO model without chimney is easily explained. The model is simple and easy to construct correctly. It is easy to use and well adapted to the techniques and social milieu in the bush. Consequently, it seems to have been adopted rather spontaneously by those to whom it was introduced.

In addition, a series of circumstances promoted the success of this programme: the presence of a potter in the village, of a women's president and a dynamic Peace Corps. Furthermore, the 30 per cent improvement on normal yield is understandable because the heat becomes enclosed in a combustion chamber, escaping all around the periphery of the receptacle which is almost entirely enclosed in the fire.

2. DISCUSSION

Some people hoped for better efficiency from the stove. However, obtaining a 30 per cent improvement with a very rudimentary fire at a very low price, negligible in fact, already represents a considerable performance and we recommend the extension in the use of this model wherever possible. That means:

(a) The bush zone
wherever cooking is done in lean-tos which are not very well closed and the smoke can escape into the room. It gets out without difficulty and without discomfort to the occupiers.

(b) Improverished area
where a very small sum represents an effort which cannot be asked of the people.

(c) Type of cooking
The type has been experimented with only in a cooking region where no "TO" is made. The stoves should be adapted to this dish, which requires a pot of round form which can be fixed in a model of different design (see sketch).

(d) A place under shelter
It is essential for this BANCO model to be placed where it cannot be damaged by rain and not too often broken, because this results in discouragement of the housewives and abandonment of the product.

3. RECOMMENDATIONS

A considerable number of this model have been made. We would add the following recommendations:

- reduction in the size of the combustion chamber (light);
- usage not requiring much intervention by outside advisers or craftsmen. To be promoted as indicated in Part 5;
- this model should tend to become the basic model in the poorer bush area with cooking under shelter or in huts not tightly closed.

B. THE BANCO MODEL WITH CHIMNEY

1. COMMENTS ON THE RESULTS

This model is more complex and might be expected to have a higher efficiency. The apparently lower efficiency than expected is not indeed very significant. In any case we believe that this model is not very much better than the previous one, for several reasons:

(a) Being more versatile, it is at the same time more complex and therefore more difficult to build well and operate properly.

(b) The chimney for evacuation of the smoke, permitting its use in a closed place, has given rise to many problems: smoking, cracks, poor aeration, insufficient height, fragility, etc. It is therefore a cause of reduced efficiency.

(c) It is also more difficult to use: since there are no metal plates to close unused holes, it is not always remembered by users that the second and third holes must be closed and the result is that they remain open and efficiency falls, etc.

(d) This model also tends to be more fragile than the BANCO model without chimney.

2. DISCUSSION

We therefore recommend the use of this model but we believe that a number of comments, suggestions and improvements, which we shall discuss for the definitive stove, will be useful for this model.

The two existing models in Senegal seem to indicate a current trend. There will be a tendency towards two basic models:

(a) a simple and cheap model for the bush areas;

(b) a more complex model adapted for the urban areas, the urban model involving a money payment and the intervention of a tradesman or technician.

3. RECOMMENDATIONS

A considerable number of this model have been made.

We would add the following recommendations:

- Whenever possible an upper metal plate should be added;
- Develop a standard size for the combustion chambers and the air intakes and outlets;
- Respect certain essential standards in the construction of the chimney;
- The cement plaster covering is not necessary;
- The size of these stoves can vary according to areas and users. This model should tend to become the basic model in urban areas where the cooking place has walls and a closed roof. Further on we shall indicate recommended average dimensions.

C. LOW MODEL IN CEMENT

1. COMMENTS ON THE RESULTS

Efficiency does not seem to be improved over 3 stones. Sometimes they appear to be even lower than in the three-stone version. This outcome, no doubt the most surprising of our measurements, may appear improbable, but we consider it to be easily explainable:

(a) Cement is not a very suitable material for this type of construction. It does not have the refractive effect of the BANCO and it tends to dissipate the heat rather than accumulate it.

(b) The conception of the stove is not the best. The combustion chamber tends to be too large; the smoke passages and the air intakes and outlets are not very well balanced (likelihood of excess of cold air);

(c) The stove is very low for working and difficult to see and this means that the housewife tends to fill it more than she would if she saw the fire (to be sure that it does not go out);

(d) In families observed in the urban milieu, the person who does the cooking is perhaps less directly concerned by the wood consumption than the woman in the bush who has to walk several kilometres to gather wood;

(e) Normally users are completely convinced that the stove saves energy. Sufficient emphasis has not been placed on the fact that like any other stove it can very well not save energy if it is not used properly;

(f) The proper functioning and regulation of this type of stove is more complex than with the three-stones stove and housewives are not accustomed to it. And there do not seem to have been any serious, systematic efforts to educate the public to this new product and supply instructions for use.

2. DISCUSSION

In conclusion, without being able to state with certainty that there is no energy saving, we believe that of 40 families using this type of stove the results are sufficiently clear to say that:

The saving of energy is at best rather small. From the point of view of performance it seems that there is indeed very little difference between the NOUNA, KAYA and AIDR models.

3. RECOMMENDATIONS

A fairly large number of this model have been constructed. See the results and discussion on this in Part 7. We would add the following recommendation:

- We recommend the gradual abandonment of this model or at least its restriction to limited areas of use.

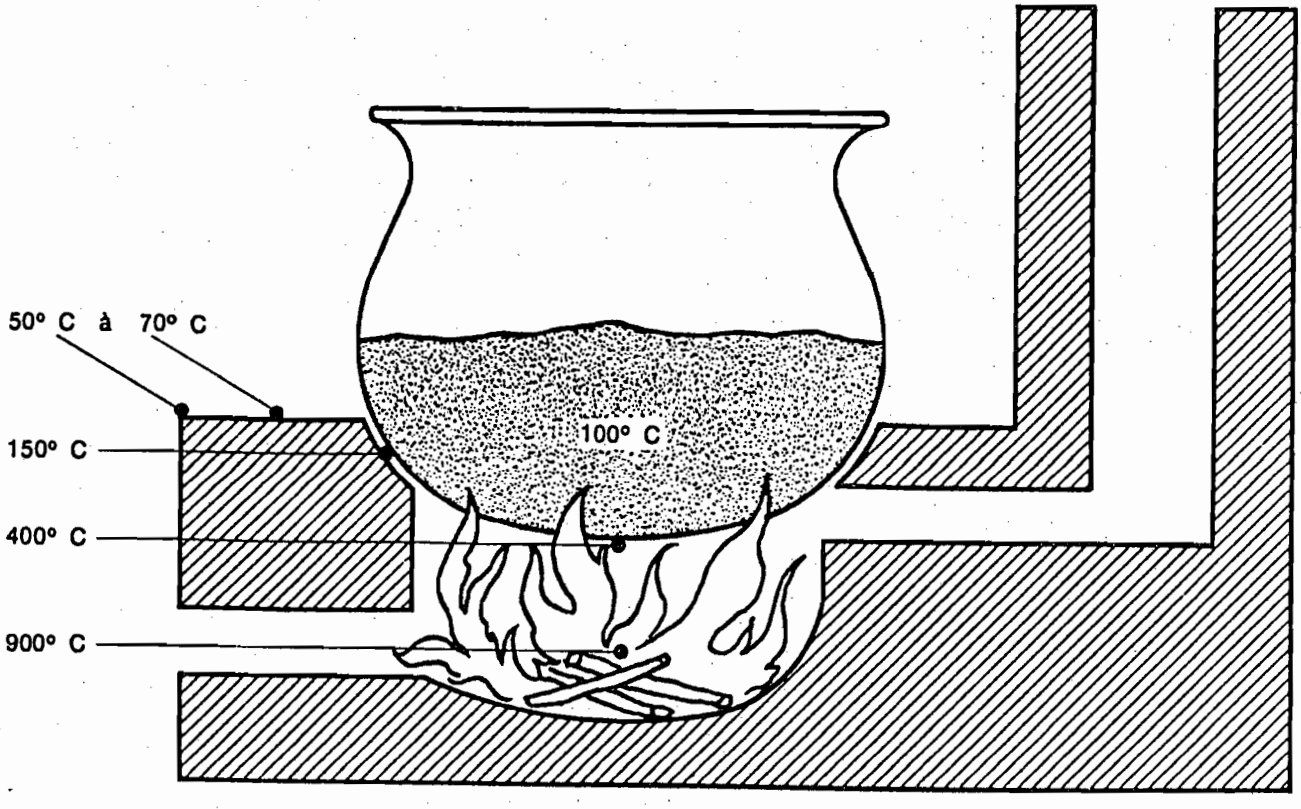
D. THE STRENGTH AND RELIABILITY OF IMPROVED STOVES

In addition to the study of yields we have taken careful notes on the dimensions and strength of improved stoves.

We conducted a number of temperature tests on the stoves while in operation in the homes. Observations on the effect of wind velocity and variations in the ambiant temperature and humidity could not be carried out because of the fact of being always in areas without wind, at a steady ambiant temperature between 36 and 40°C in the dry season.

THE FOLLOWING ARE THE OBSERVATIONS RECORDED

(a) Dimension and temperature during working



(b) Cracks and splits

We made careful observations whenever we discovered stoves which were cracked or split and we recorded the places where these splits occurred. A considerable proportion of them have cracked after only a few months of use. This is true for all the types of stove. That means that there is undoubtedly a problem of durability over time in the case of these rustic constructions. It remains to be seen whether these splits and cracks will worsen. This is more than probable. But it is too early to say whether the stove will be completely destroyed after one year, two years or three years. As far as can be judged, it would seem that the life of a stove will probably not exceed three years.

This problem raises the question of repairs and replacements. Stoves which have been damaged more than with a simple split were either abandoned by the families or used without needed repairs. We did not see any stoves which had been repaired.

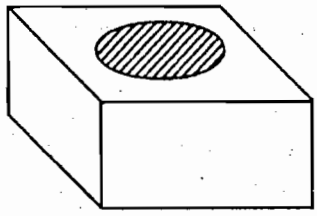
As far as the simple BANCO models are concerned, repairs could be done rather easily by the users themselves. In the case of the other models repair by the user is not so simple.

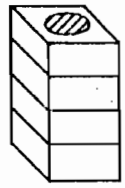
It is the whole problem of "after sales service" which arises for these products as for any other.

(c) Chimney problems

We took note of the dimensions and soundness of the chimneys. The following are the details:

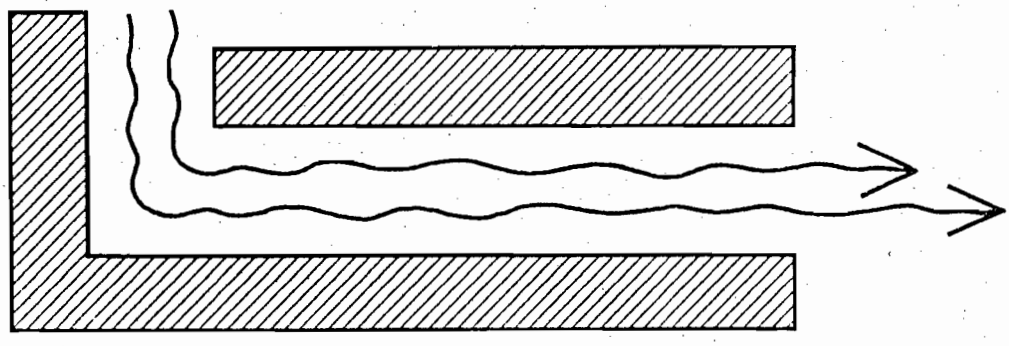
- conglomerate parpens in cement with one hole (A.I.D.R. type), diameter of hole 10 cm



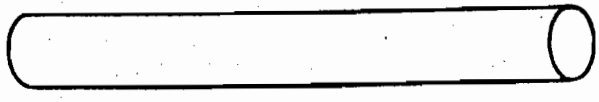


- chimneys in "banco monobloc" (CERER type), diameter of hole approximately 10 cm

BOTTOM TOP

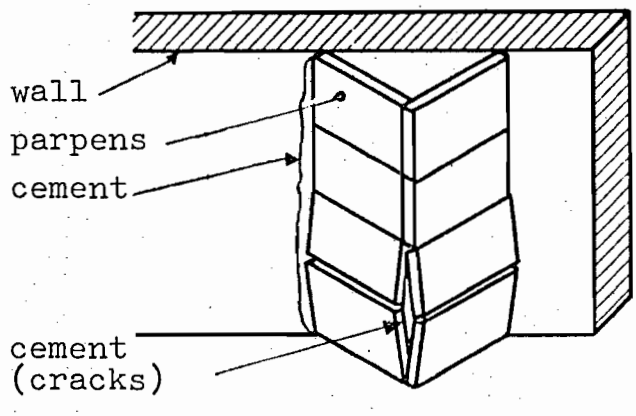


- chimneys in prefabricated conglomerate pipe, diameter of hole 10 to 14 cm



- chimneys with flat cemented parpens

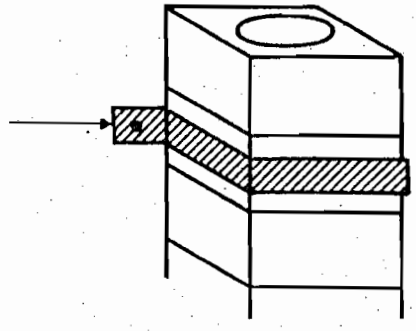
BAD



- parpens in "banco" with one hole, diameter of hole 10 to 15 cm

GOOD

(need to place an iron towards the top of the wall)



In general there is a big problem with chimneys. They are not of proper height. They are very often cracked or detached from the wall. They are certainly an important factor in the poor yields observed with the models in cement in UPPER VOLTA.

PART 8 - TECHNOLOGY

A. THE TECHNOLOGICAL EVOLUTION CONTEXT

The problem involved is to develop a few models of improved stoves. Over a period of five to ten years it is probable that such models will spread throughout the whole of the SAHEL and consequently will number tens of thousands or even several hundred thousand, hence the importance of having technologically reliable models.

The process of technological evolution is rather standard and may be separated into three generations:

1. FIRST GENERATION: THE "THREE STONES"

The three stone generation, used since time immemorial, involves "stoves" which are very simple to operate and manipulate by the users. It has definite technological advantages:

- good combustion because there is no reduction in the oxygen intakes;
- good visibility of the fire, and easy to extinguish the fire and control combustion.

The main disadvantage: its thermic efficiency is low and there is no doubt that this will be improved with new types of stove.

2. SECOND GENERATION: APPEARANCE OF NEW MODELS

This is the present phase and it may be said that it really began in 1979, all over the SAHEL. This is the generation of the pioneers and individual initiative. This phase results in a number of models with a few hundred in number scattered here and there which makes it possible to have the first tests in the field.

At the same time theoretical studies are conducted in various places and the experts suggest certain improvements relating to particular aspects.

This is an inevitable phase in technological innovation, and is somewhat confused and disorganised. This is not a bad thing in itself. In view of the present state of the different projects and initiatives, this phase is clearly not yet terminated. It would be an illusion to think that we have arrived at a product quality which is sufficient to advance to the stage of large-scale distribution.

However, it would be a good thing to begin more scientific and more specific work in relation to each technical aspect of the problem while continuing to allow a free hand for the development of new models. In fact, we suggest one which has hardly been distributed at all but which deserves to be: it is a combined version of BANCO and METAL. It will be referred to further on.

3. THIRD GENERATION: MASS DISTRIBUTION

This is the stage of large-scale distribution with reliable models, proper distribution structures and possibilities for technological control of the equipment supplied. None of these conditions exists at present but the stage could no doubt be reached by 1982 or earlier.

In a population of approximately 20 million inhabitants in the SAHEL it may be estimated that there is a potential for approximately 2 million improved stoves. This gives an idea of the range of the market and the need for caution and organisation in relation to both the technology and the distribution structures.

The present report is a contribution in the effort required to advance to a more technical stage of greater precision.

B. DETAILED EXAMINATION OF THE TECHNOLOGICAL FEATURES

1. THE MATERIALS

(a) BANCO or COB

Properties:

The technique of "banco" or "cob" is a process which has been known for a long time in many parts of the world. It consists in a conglomerate of a particular ratio of clay and sand placed in a mould and the banco is then tamped in the mould and allowed to dry.

The result is a very resistant material. Recent studies have been undertaken to modernise this technology, particularly by the Centre de Recherche et d'Applications Terre (Centre for Earth Research and Application) which is a body linked with the University of Grenoble.

When the mixture of clay and sand is not tamped it is given the name "adobe" (a word which comes from the Egyptian "thobe" signifying brick, which gives "ottob" in Arabic, and adobe in Spanish, French and English). This is simply put into a mould and dried.

This technique is used in AFRICA since time immemorial. It was known in the various empires of EGYPT and ASIA MINOR. As far as the improved stoves are concerned banco seems to be by far the best material; first, because it is a technique which is well known in AFRICA and second because it is well suited for stoves because of its heat resistance qualities. However, it will be necessary to make sure to choose the clay quarries more carefully than has been done in the past (they are plentiful in the SAHEL). The search for the best proportion of sand and cement has been the subject of much discussion in previous reports. A mixture of three portions of sand to one of clay might be suggested as being the most common. However, these proportions may vary between one to two and one to five

depending on the types of materials. It is suggested that the earth be allowed to set for 24 hours once it has been mixed. The commonest proportion of water is 1/3.

Limitations in use

Banco tends to crack either during drying or when it is heated. It is also more fragile and friable than hard materials such as cement. In practice this means that stoves made of banco may deteriorate rather quickly. This, indeed, is what happens in the field, and that is their main disadvantage.

However they have the advantage of being more resistant to cracking under heat than is the case with cement. In the combustion chamber the banco heats and is transformed into a type of brick which is very good. The banco has the further advantage of retaining the heat, i.e. of being a good heat-conducting material. On the whole the fragility of this material remains its main disadvantage, the rest being either a minor limitation or an advantage in relation to its use in improved stoves.

Improved banco

Efforts have been made to improve the performance of the banco by mixing it with certain other products:

Banco cement

Banco with cement added in the proportion of from 4 to 10 per cent does not seem suitable for improved stoves because it does not directly increase the resistance of the mixture and in fact causes it to lose the qualities of banco in holding heat. This mixture is mainly used to reduce the erosion of the banco by rain;

Plaster banco

By adding plaster or lime in the same proportion of 4 to 10 per cent a mixture is obtained which may well be rather good for the improved stoves. It would slightly increase mechanical resistance without causing a loss of thermic properties. This variation could be used and merits study. However, we do not think it can make a radical improvement compared with the version completely in banco. It may be said that it would be at least as good and probably slightly better.

In order to avoid the problem of the cracking of the mass of banco, the construction of stoves with banco bricks may be considered; these would be placed one against the other with or without joints in banco or other material. The cracking would occur along the joints without causing deterioration of the stove.

Temperature resistance of banco: 800°C to 1,000°C.

(b) CEMENT

Cement is being used for some improved stoves either as a basic material or as a surface coating to strengthen the banco. This technological choice has been made for various circumstantial reasons. Unfortunately it must be categorically stated that it is absolutely unsuitable for making stoves. All of the ones we saw had cracked. It is not possible to say how long they last. It may simply be said as far as the technology is concerned that cement is a material which is systematically avoided for all uses comprising exposure to heat. The Annex gives a table from the ITPTP which clearly shows that at 60 to 80°C the cement structure begins to decompose through loss of hydroxides. The result is decomposition and cracking. Although this material has been used in different parts of the world for making stoves it remains nonetheless true that cement is not a suitable material. And it is unfortunate to begin with a wrong technological decision.

If the cement is applied on the surface coating of a banco stove, the different rates of expansion and behaviour in humid atmosphere results in detaching and cracking of the coating. This is a further cause of unsatisfactory results.

A housing project in AGADES, built in BANCO, involving trials with cement rendering and cement incorporated in the banco seems to confirm this opinion.

To this must be added the fact that cement is not a familiar, native product and is expensive compared with banco. It greatly increases the cost of a stove. Furthermore, cement is not such a good heat conductor as banco. This means that it tends to lose heat through the sides rather than hold it. For these various reasons and without wishing to prejudge the life of improved stoves made of cement it must be said that these stoves are based on a poor technological choice and in all good reason they should be gradually eliminated.

Transitional situations may be envisaged in which an external coating in cement, for example, would be maintained even though it is likely to gradually crack, with the interior being constructed in banco.

One of the disadvantages of cement is of a technical rather than an economic nature. A stove of cement is not only expensive but it is fixed. And, in the towns, such as, for example, OUAGADOUGOU, it is estimated that approximately 60 per cent of the population are tenants. It is normally unlikely for tenants to have a stove built in cement at their own expense when they may be deprived of their lodging at very short notice. This therefore excludes at least half of the population, the most disadvantaged half, from the use of improved stoves.

Heat resistance of the cement: 60° to 100°C.

(c) BRACES AND REINFORCING

The above materials may be envisaged with their mechanical properties strengthened by means of iron bars or barbed wire in the mass of banco or cement. This is quite possible and valid from the point of view of the resistance of these materials. Care must merely be taken to use reinforcing materials of small diameter. Large pieces of steel would be likely to contribute to cracking of the mass through expansion when the temperature rose.

(d) TOP PLATES IN: CAST ALUMINIUM, CAST STEEL AND STEEL SHEETS

The fragility of banco, as of cement, applies particularly on the top of the stove. This is where the dishes and pots are put and it is the part which suffers most mechanical damage both because of the weight of the pots and because of the expansion. It has therefore been suggested to put a metal plate with one or several holes on top of the stove. This metal plate could be simply laid on the top or it could have legs fixed in the mass of the banco. It could also be inserted in the mass of the banco in such a way as not to slip. The holes should have a movable cover.

These cast or sheet plates have a heat resistance of:

- cast aluminium: 600°C

- cast steel and sheet steel: 800°C to 1,000°C.

During the tests conducted on working stoves it was noted that no point of the cast plates reached the critical temperatures of 600°C for aluminium. These materials could be used. They have the advantage of involving a familiar local technology since there are aluminium founders already making pots who could make these plates without difficulty.

It is desirable to use local skills and technology whenever possible. These plates could also be made in cast steel but it would be more expensive and unusual. They could be cut from waste steel sheeting provided it was sufficiently thick. Recommended thicknesses would be as follows:

- cast aluminium: 5 mm with reinforcing ribs

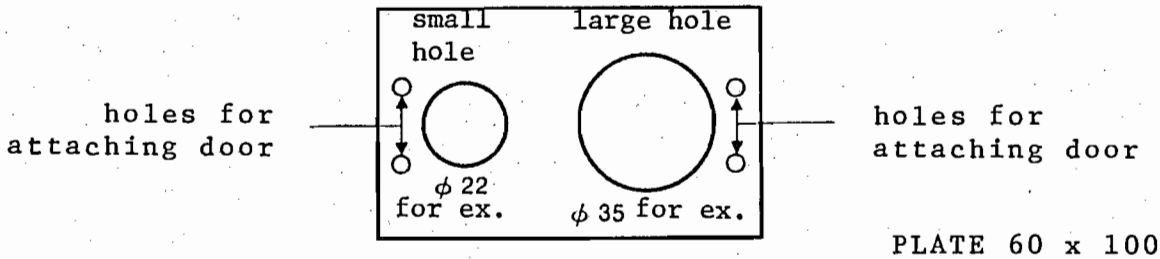


PLATE 60 x 100 for example

- cast steel: 5 mm

- steel sheeting: at least 3 mm with reinforcing ribs (for example, with perpendicular, welded strips).

These plates would be covered with thinner sheeting.

The top metal plates, much thinner than banco or cement stove tops, make it possible to place dishes in closer contact with the flames and the heat radiation.

Limitations in use:

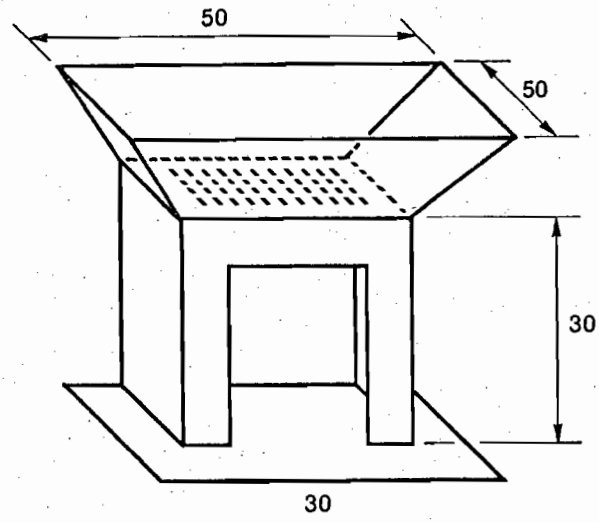
These top plates would certainly be very useful from the technological point of view. This, indeed, is how all wood-burning stoves have always been made. They would have the disadvantage of requiring a tradesman and involving a financial expenditure.

We tried to quantify this and discussed it at the markets with suppliers of utensils and hardware. It would seem that a price of CFA.2,000 may be indicated for the aluminium plate. Cast plates would be much more expensive. Conversely, steel sheeting with holes would be much cheaper because it would be possible to use waste sheeting reinforced with iron.

Local tradesmen seem very confident in welding, cutting and shaping sheet metals and, in addition, local technology and business would be used. In the very poor rural areas only the pure banco model is possible at present.

(e) COMPLETE METAL MODELS

Small models of stoves entirely in metal, usually folded waste sheeting, sold for CFA.500 to 2,000 on the markets, are used for cooking with wood charcoal. They are very suitable for the purpose. They are called Madagascar stoves.



Their use is very widespread in the towns and they are very suitable where there is not much space for storing wood.

Thin metal sheeting has of course the disadvantage of allowing much heat to escape. In addition, the height of the pot compared with the combustion chamber is not easily regulated on these stoves.

In general, these stoves are simple to use. They save energy in the sense that the quantity of material used for burning is very easy to regulate. But the yield must be less than the

yield from improved wood-burning stoves in banco. Because the heat yield from wood charcoal is less than from wood, the combination of metal stove and wood charcoal is probably not very efficient. We do not have any statistical data on this subject, however, because the present study dealt mainly with the improved stoves compared with the three stones.

The metal wood charcoal burning stove may be situated therefore between the three stones and the improved stove from the point of view of efficiency.

2. OPTIMUM DIMENSIONS OF THE IMPROVED STOVE

When a stove is being constructed, a number of decisions must be taken as to dimensions and the positioning of the different parts.

These decisions can be made without hesitation from the models of cookers which have existed since the 19th century in the industrialised countries. In practice, the main problem with improved stoves in Africa is the price problem. It is not possible to install a cast cooker in every home because it would be much too expensive. That is why we have used various replacement materials which are better suited for the African environment.

As far as concerns the dimension of the combustion chamber, the chimney conduits and more generally the arrangement of the different parts of this stove, there need be no hesitation in using the dimensions of the major makes of wood-burning stoves (Godin, Arthur Martin, etc.). These firms have been using and testing these models for a long time with a view to efficiency and energy saving.

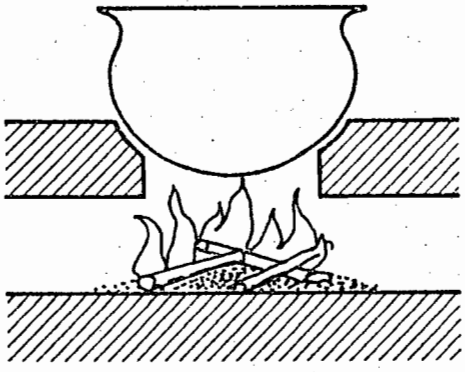
Of course, they must be adapted to the African way of living, for example, by reducing the size or the height if desired. But elaborate thermic studies will probably not bring much change, compared with the models sold in EUROPE, so far as relates to the optimum dimensions of the internal cavities of the stove and the chimney.

3. THE DIFFERENT PARTS OF THE IMPROVED STOVE

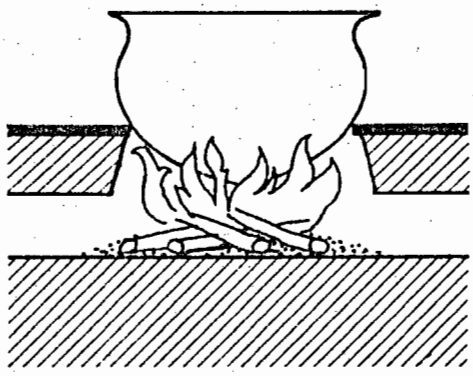
(a) THE COMBUSTION CHAMBER

Dimensions noted in the field in already constructed stoves: usually circular cavities of 25 to 30 cm in diameter and 15 to 30 cm high. This is probably too much. It is suggested that the size of these chambers be reduced, and this would force the user to put in less wood at a time, which in practice

would not reduce the thermic performance. A slightly elongated shape is recommended to conform to the shape of the pieces of wood.



BANCO MODEL WITH CHIMNEY



BANCO MODEL WITH CHIMNEY AND METAL PLATE ON TOP

The desirable depth is from 15 to 20 cm. The width and length could, for example, be 20 cm x 30 cm.

(b) HOT AIR INTAKE AND OUTLET

The hot air could be taken in by the same opening as the opening for the wood or it could be underneath if there are bars or a door. In any case this entry must be as small as possible to avoid too great an intake of cold air which would rapidly evacuate the hot air in the fire and carry it into the chimney, which would reduce the efficiency of the stove. A hole of 5 cm x 5 cm or up to 10 cm x 10 cm, for example, might be sufficient.

The hot air outlet should also not be too large. However it should be larger than the intake to avoid smoking. It leads either into the chimney or into the second cavity, with a hole for placing the pot of hot water which is being heated, for example. It could also be flat and broad, for example 10 x 25 cm so as to heat the top plate and reheat a flat or round-bottomed receptacle placed in a second hole. Unfortunately, in many cases it is noted that the second hole is not blocked with a receptacle, and this results in a loss of air which upsets the draught and reduces yield.

(c) THE CHIMNEY

Observations in the field have shown that almost all the existing chimneys are unsatisfactory. The chimney is a decisive element in the proper functioning of the stove. Here again there are practical courses and manuals for use by heating tradesmen, designed to show how to construct this portion. Without going into details, here are some indications:

- interior: desirable diameter, 12 cm;

- height: standards in FRANCE require a minimum height of 3 metres to ensure a good draught and they can rarely fall below 2.5 metres;

- the conduit must have the smallest possible curve and should extend above the roof for at least 50 cm to avoid smoking and lack of draught which could be a cause of suffocation of inhabitants and loss of yield.

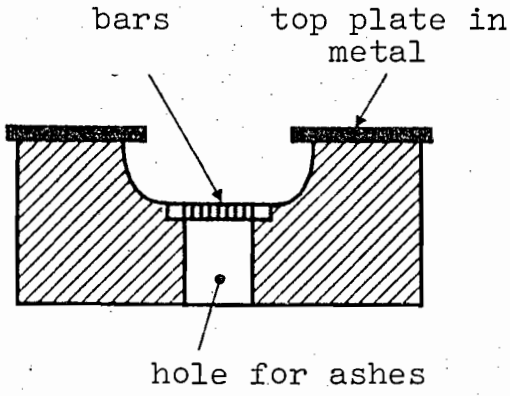
The chimney could be constructed in monoblock bricks superimposed as is the case with the chimneys in OUAGADOUGOU but it should be fixed with at least a "U" iron fastened in the top of the wall. The majority of chimneys seen were detached from the wall.

We did indeed find Banco stoves with chimneys, having yields below those without chimneys, chiefly because the existing chimneys were practically useless.

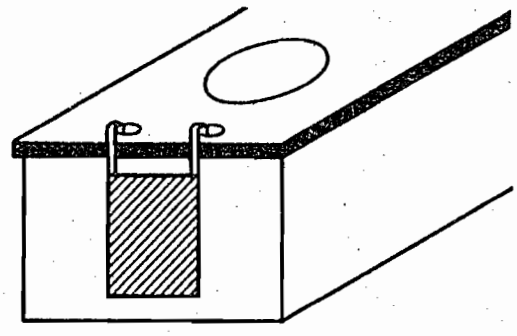
(d) BARS, VALVES AND OTHER ACCESSORIES

As pointed out by the authors of the different reports, the various models in existence have bars, regulating valves, closing doors and other stove accessories. We did not see a single cooker in the field which still had a closing door. There is no doubt that from the point of view of thermic yield, these accessories give good control of air intake and outlet. But it is essential to have fine adjustment, with strictly respected internal dimensions and, on the whole, carefully planned industrial design. In other words, we believe that neither the African woman nor the constructions by local craftsmen using local materials will be able to ensure sufficient precision in conception and management to make the best use of these improvements.

Models with bars could be tried and distributed. It would probably be a good thing but we believe that this should not be done with the majority of stoves. A permanent door to stop the entry of cold air could also be attached to the top plate. It would close off the opening. In the case of bars it would be necessary to have an internal cavity under the combustion chamber to collect the ashes.



CROSS SECTION OF COMBUSTION CHAMBER WITH TOP PLATE AND METAL BARS



FRONT DOOR ATTACHED TO TOP METAL PLATE

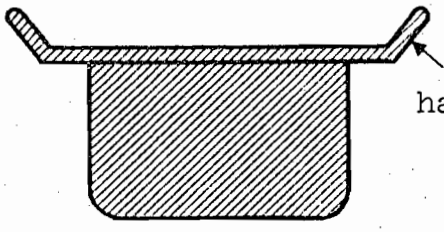
All these parts, chimney valves, flame deflectors, dampers, hot air channels for a choking effect, hot water boiler incorporated in the body of the stove etc., could be envisaged but in a second stage when the more simple models had become generalised.

(e) COOKING UTENSILS

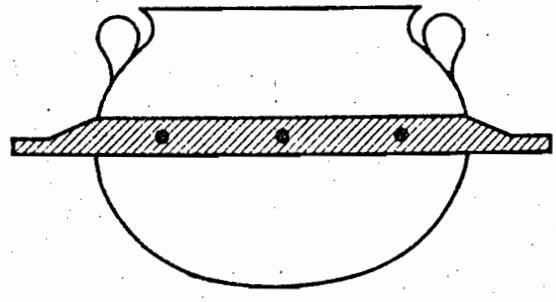
Improvement in performance will gradually result in the use of cooking utensils which are better adapted to the improved stoves.

For sauces:

Flat bottomed saucepans may be used, with handles or rims to make it possible to place the saucepan in the fire, the rim or handles serving to block it.



SAUCEPAN FOR MAKING SAUCES



RING FOR FIXING ROUND-BOTTOMED POTS

Sauces requiring much time for cooking would be prepared much more efficiently in this type of receptacle.

We have noted that there are saucepans on the market somewhat of this type but they are usually made of aluminium sheeting which is not sufficiently thick to stand direct exposure to fire.

It would be necessary therefore to have saucepans which are somewhat thicker, for example in cast aluminium or aluminium sheets (pressed and approximately 2 mm thick).

- For round-bottomed pots in which rice or "TO" is prepared it is suggested to have a ring fixed around the pot to allow it to be placed deeper in the fire.

  This could also be done without difficulty with existing pots sold on the market, by adding a separate piece of metal.

  Adding this fixed ring, however, would give a smaller improvement than the flat-bottomed saucepans for the sauces as mentioned above.

- Fire holes and pots:

  It is recommended to make the small hole for the saucepan just over the fire and use the second hole to preheat and heat rice or "TO". Since the pot has time to be reheated while the sauce is being prepared, wastage of heat is avoided. While the sauce is being prepared the rice or "TO" or warm water has already become hot.

(f) SIZE OF WOOD, MAINTENANCE, OPERATION AND CLEANING

All the cookers seen had only one year of service and the problem of cleaning and maintenance did not seem to have arisen.

Furthermore the stoves may well be broken before there is need for cleaning. If it is hoped to make durable models, it would be necessary for the chimney to be cleaned about once a year Breaks and cracks would likely occur and must be repaired.

Furthermore the size of the wood used at present is very close to the size of the wood for the three-stone fires, while in fact the wood should be cut much smaller approximately to half, so that it goes more easily into the fire, which is now also smaller.

There is no doubt that the tools used by families to cut wood are often of a quality which makes it difficult to cut it into small pieces. However, by reducing the size of the wood there is a considerable reduction in the quantity of wood consumed and the final result is that there is not such a large amount of work to be done.

CONCLUSION

From all that has been said under the above headings it is clear that whenever possible there is a tendency to use local materials and technologies rather than imported ones.

As for construction methods, these are relatively simple. This is where apprenticeship centres should be used to provide training for heating craftsmen.

Follow-up and improvement in technological details, materials and construction are recommended as a follow up to this report. Training centres for craftsmen would be in a position to prepare technical leaflets, methodological notes and small tools. Practical construction advice could subsequently be given in the apprenticeship centres.

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- L'énergie dans la statégie de développement du Sahel (CILSS/ Club du Sahel), Paris, (ouvrage général servant de cadre à la présente étude).

- Amélioration des foyers pour l'utilisation domestique du bois de feu (CILSS/FAO), Etude très spécifique, sur le terrain, des foyers améliorés.

- Some performance tests on open fires and the family cooker (K. Krishna Prasad, Université de Eindhoven) Etude théorique des performances du foyer 3 pierres comparée à un modèle de foyer avec circuit de combustion secondaire.

- Les forêts tropicales et l'énergie (Centre technique tropical, Nogent sur Marne) Etude très complète du pouvoir calorifique des bois et de l'exploitation de la forêt tropicale.

- Guide technologique "Vita" (Cuisinières économiques Lorena, Mount Rainier, Maryland) Petite note sur un modèle de cuisinière, dite "Lorena".

- La participation des femmes au développement rural. A propos d'une action d'animation rurale féminine en République du Niger (IRAM - Paris).

- Energy and cooking in the Sudan (L.U. Brattle, Home Economy Department, Université du Surrey).

- Programme de développement de fourneaux en milieu familial (Projet des femmes intégré au programme d'assistance forestière allemande) Quagadougou - HAUTE VOLTA.

- Status of Wood stove development in Upper Volta (G.S. Dutt, Princeton University) Etude spécifique sur les foyers améliorés en HAUTE VOLTA.

- Improved cookstoves for rural Senegal (VITA, Maryland) Etude spécifique sur les foyers améliorés au SENEGAL.