IMPROVED COOKSTOVES FOR RURAL SENEGAL

CONSULTANTS' REPORT TO VITA
FOLLOWING FIRST WORKING VISIT TO SENEGAL
APRIL 1980

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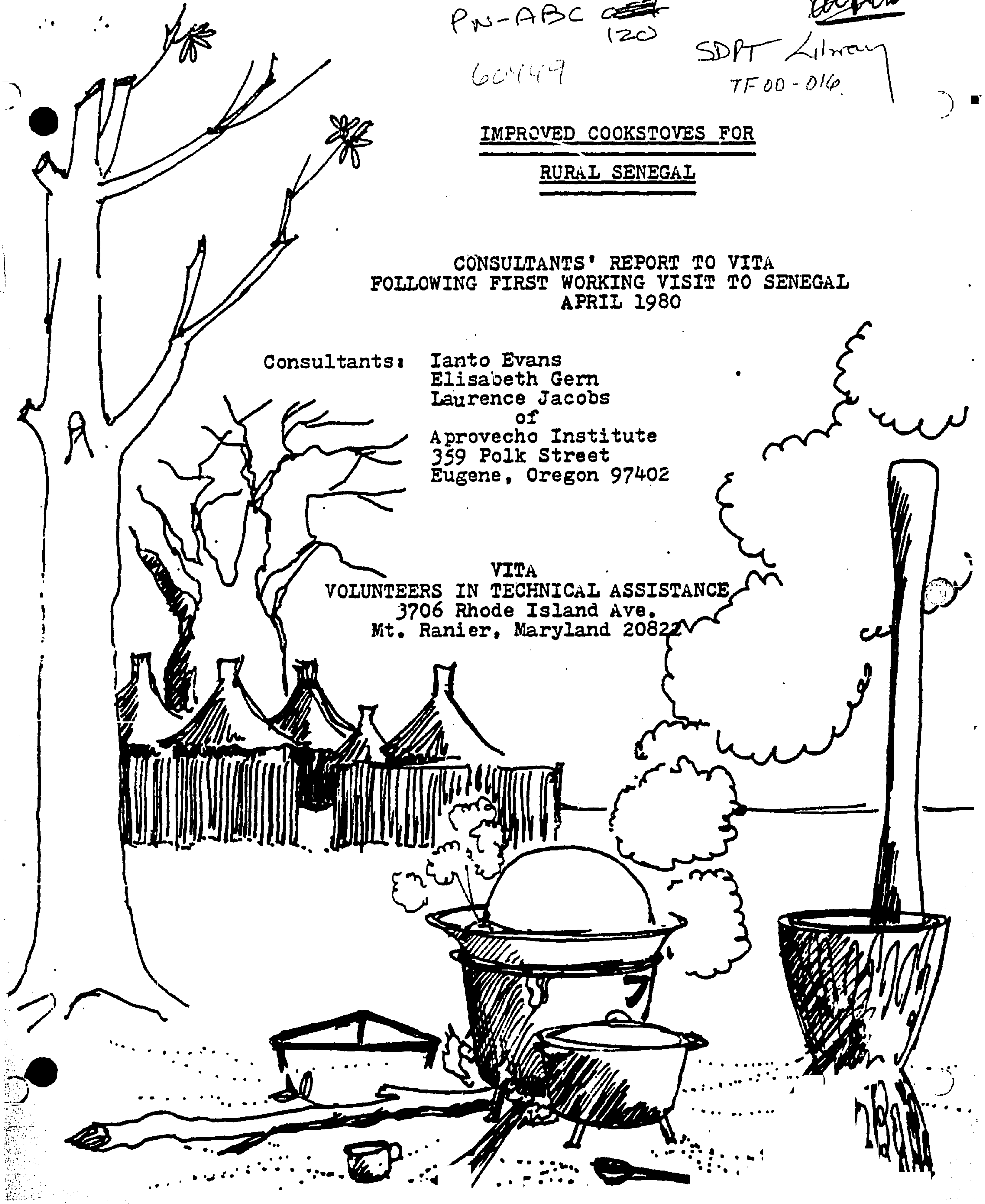

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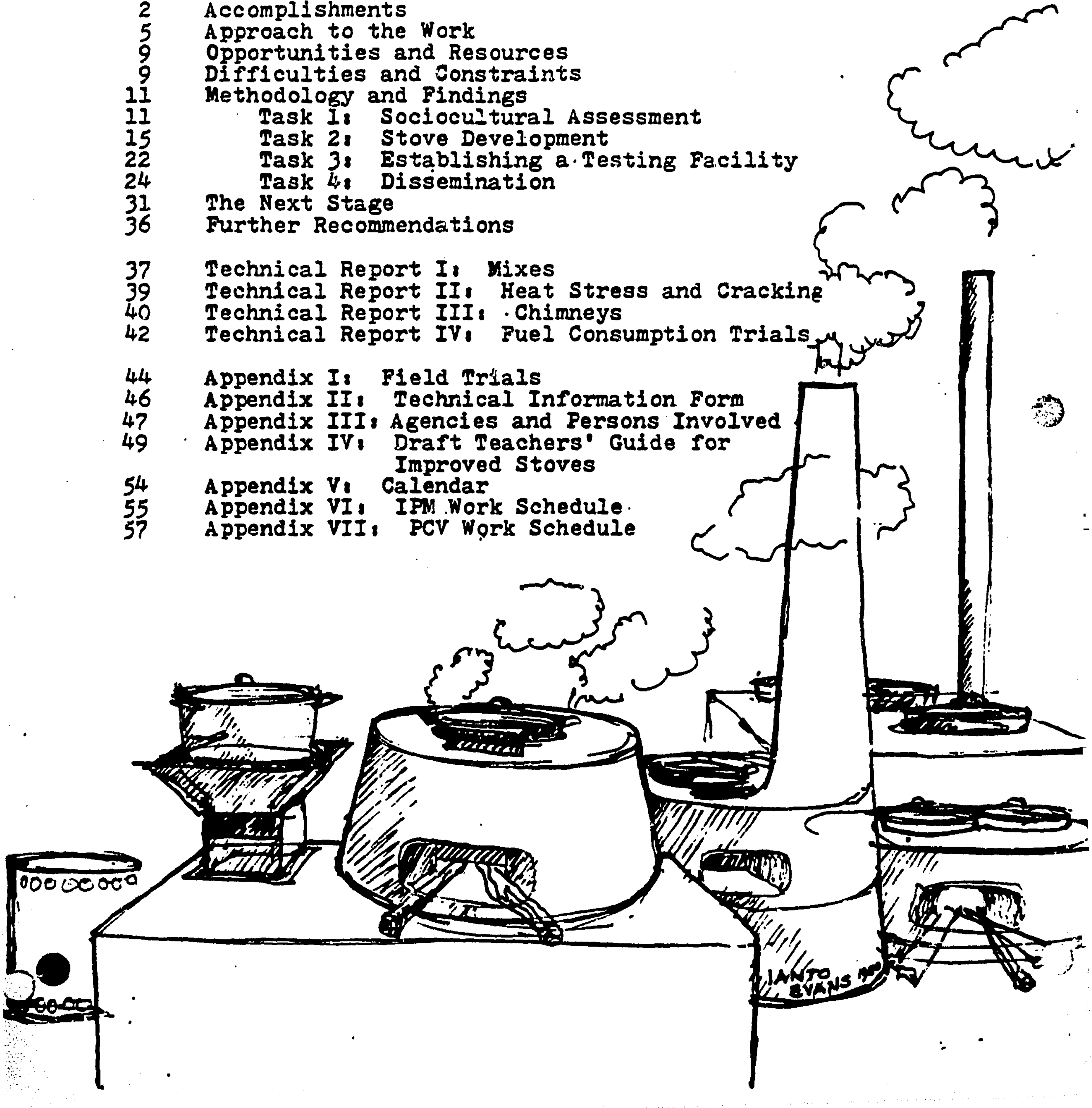


THE TASK ASSIGNED

1) Design of prototype woodburning stoves.
2) Training of Senegalese personnel at CERER to build the stoves.
3) Design of a plan to ensure that the prototype stoves are distributed, tested and modified as appropriate.
4) Training of Senegalese personnel to implement the above plan.
5) Preparation of a final report to include summary of activities, persons/organizations contacted, recommendations for project follow-up and copies of all designs/plans developed under this contract.

As has been pointed out by AID staff in Washington, this is an immense task for only 5 weeks. During the course of this work, important omissions were noted and added to the schedule. For instance, although an investigation of charcoal burning stoves was overlooked, it is of sufficient importance that we have added it to our mandate.

Upon arrival in Senegal and having assessed the work, we redivided it into four separate jobs:

1) A socio-cultural assessment of needs, constraints and opportunities,

2) Development with villagers of a basic system for building stoves,

3) Work with IPM to develop a training and testing system,

4) Generate a mechanism for promotion and dissemination.

A start has been made on each of these stages; a method has been developed for implementing them. But it would be naive to suggest that the work is complete. We can merely be assured that if the method is followed, with modification necessary as new information comes to light, the project has every chance of being unusually successful.

This document serves three combined functions:

a. An account of work done.

b. A plan for ongoing work.

c. Most important, a methodology of development which is most appropriate to these conditions. As such it could be a model applicable anywhere in the world to the development of locally-responsive technologies by local people with assistance from outside agencies. It may be a key to introducing locally-inspired stoves and other simple devices to meet the urgency of need in Sahelian countries.

ACCOMPLISHMENTS

Even our own high expectations are exceeded. We are able to report that after only the first 5 week's work we have proceeded further towards a solution than has anyone in all of the last 20 years.

1. We have developed a basic Senegalese stove that answers all our basic goals:

- it costs nothing to build,
- it is built entirely with local materials,
- it uses only common household tools and no special skills,
- it is of flexible enough design to accomodate most conditions,
- it saves 50% of the firewood previously used,
- it will last a full year without attention,
- and it was designed in collaboration with villagers in direct response to their needs.

2. We have constructed more than 20 stoves in field trials, of 4 different models:

- M3 type chimneyless 1-burner
- M2 type chimney 1-burner
- M1 type chimney 2-burners
- Institutional chimney multi-burners.

These trials are built in eight departments of the country, representative of the range of conditions prevalent throughout the wes-t[illegible] [illegible]one where 80% of the rural population lives.

3. [illegible] Dakar at IPM we have built 15 trial models each of which is b[illegible] tested. Tests include: material strength, hardness, resist[illegible] to cracking; size and shape of firebox; the effect of damper d[illegible]; coatings for weather resistance; chimney height diameter and m[illegible]ls; fuel efficiency; ease of operation; rate of heat transfer. W[illegible]e trained an investigator and a team of masons in building and [illegible]sting methods, and have begun training a demonstration team w[illegible]l teach construction at workshops held in the field. IPM now have a full work schedule until December 1980.

4. Work has begun on improved charcoal stoves, and developing better insulated materials for heat retention in the firebox.

5. The PCV assigned to the project, Karen Nelson, was fully involved in the work of the first 5 weeks and will be national coordinator of development and dissemination. She has already met with and been assured of support from several government and aid agencies and has herself taught two workshops on stove construction.

6. Enthusiasm and interest has been expressed at every level from rural peasants to President Senghor. The first press conference

will be held at IPM in mid-April.

7. With our support and encouragement, several agencies have already begun work on stoves. They include Promotion Humaine, Maisons Familiales Rurales, Peace Corps and the German agency WFD. Several others are now committed to widespread instruction. They include SODEVA and CER.

8. Cooking conditions, fuel availability and local skills/materials have been assessed in parts of several regions, representative of all Western Senegal: Louga, Thies, Cap Vert, Sine Saloum, Djourbel, Casamance.

APPROACH TO THE WORK

The overall objective is to make improved stoves available to 3 million rural peasants (and later to 2 million urban inhabitants) all over Senegal, as quickly as possible. The work has two major components: development of the technology and its diffusion. If stoves are to be easily available to everyone, they must be built in the villages, of local materials by local people. This and the exigencies of heavy mass needed to conserve heat and raise combustion temperatures point to a heavy mass non-portable static stove.

Almost all distribution mechanisms for spreading innovations are arranged to sell manufactured articles pre-assembled at central locations. As the market is strongest in urban centers, these are targeted first, assuming a filter-down effect will bring in the rural population to buy. With products that are exclusively agricultural (eg. pesticides) heavy persuasion is often exerted by representatives of commercial manufacturers, operating through government agencies, a synergistic arrangement through which both stand to gain. The assumption is of a "market" and a standardized mass produced "product" which is hard to modify once manufacturing is tooled-up to produce it. The inference then is that the individuals buying it must themselves adapt, rather than the product being adjustable to individual needs. Also if conditions change from time to time it is difficult to adapt the product to new conditions. Even the most sophisticated market analysis cannot ensure that feedback will generate continuous modifications of a product to better fit the customer's needs, unless competition for large profits is involved.

We are faced with an unusual situation for which there are few precedents except our own experience in Guatemala, Nepal and Java. We have however a certain freedom in that the constraints of standardization, mass production and delivery no longer need apply. There is no profit involved. No individual stands to gain except the people themselves.

Here are the needs:

(A) The people are intelligent and see their needs clearly, but they are constrained by the possibilities visible to them. They lack only technical expertise and the assurance that solutions are possible to be able to solve their own problems. This is not a question of feeding palliatives to peasants "because it will be good for them". So, firstly we must set up a system of dialogues between villagers themselves and between villagers and technical helpers to make sure we are all responding to the problems they themselves identify. As stressed in the AIP (pp. 21, 34, 36) this technology cannot be successfully introduced without active participation of the village women. This way, not only will it accurately reflect their subtlest needs but their sense of involvement in the project is essential to its success. It was discovered that much of the guarded non-enthusiasm we were greeted with from officials in the first stages was a result of attempts to pour in "appropriate technology" imported wholesale from other places. A case in point is that of the solar cookers developed in India for totally different cooking conditions, which were introduced to Senegalese villages without adequately involving the local people. They have not been accepted as they lengthen cooking time from around an hour to four or five hours. Worse, the villagers in areas in which they were introduced are reportedly highly suspicious of further attempts to change their cooking habits.

Messrs. Steedman and Burril's sentiments in the AIP should be strongly endorsed:

> "...a basic concept in this project is the importance of optimizing local control of technology whenever feasible. Much technology introduced into rural areas has not been used once the external support system that brought it has left. In many instances problems developed which people were not trained to solve, or for which they did not have adequate material or funds. Often, people have felt that new technology was not really theirs and hence that they were not really responsible for it. In other words, they had not integrated it into their lives. If new technologies are to be put into service to improve peoples' lives, this integration is necessary. Technologies must respond to needs felt and expressed by the villagers, which they are willing to try new techniques to alleviate." (pp. 34-35)

We can be quite certain that with some unexpected technical possibilities suggested to them, villagers will devise their own stoves. This has in fact already been successfully tried (see p. 19). Local pride in locally-developed stoves should be encouraged at every level; the stove developed in Kebemer for instance should be called "the Kebemer stove" and publicized as such, even if it closely resembles its neighbor "the Louga stove".

(B) A distribution mechanism is necessary to make innovations of one village available to others through an information exchange with access to facilities for kinds of testing which are impossible at a village level. Information on qualities of materials, precise shapes, sizes, etc. should be made available through this network, together with stove information at present not available to the people, e.g. stove ideas from other countries with similar problems.

At present in Senegal, communications are heavily concentrated into a radial pattern from Dakar out to each region. Communications between geographically adjacent areas often must go through Dakar. Thus information spread between one department and another is often indirect and must go through official channels, which dilute and distort it. Now links should be built web-fashion for this project between the radial spokes of Dakar's wheel, though in some areas this may already exist locally in the form of traditional inter-village dispersal.

(C) There should be made available to ordinary people not a product but a <u>system</u> of stove building with which they can build a stove to satisfy their own family's specific needs.

This model for stove development and dissemination of information is considerably different from the standard approach. Above all, it <u>involves the user</u>, and is an unending cycle of INVENTION - TESTING - IMPROVEMENT - DISSEMINATION - TESTING - FEEDBACK - INVENTION. This should ensure continuous <u>evolution</u> of an infinite number of stove designs to suit every situation. Development and dissemination are integrated at every stage.

OPPORTUNITIES AND RESOURCES

1. Sand exists everywhere; water most places; clay is never far away.
2. There is grave rural unemployment, especially of men, seasonally. This offers a ready labor force.
3. Native ingenuity is high. People know all the local resources available.
4. The acute firewood shortage makes people keenly aware of the problem and anxious to try new ideas.
5. The enthusiasm of many officials and volunteer workers, most notably Peace Corps Volunteers and Promotion Humaine will be of great help.

DIFFICULTIES AND CONSTRAINTS

1. There is no clear precedent for the type of development we envisage.
2. There is extreme rural poverty, no capital reserves, little metal, cement is expensive; the essentials of a technical society are often lacking: there are few tools, there is even a shortage of hard surfaces to mix sand and clay on.
3. No comprehensive national extension system was identified. In the country, there are no newspapers or TV, few schools. There is extremely high illiteracy. The administrative infrastructure is heavily biased to Dakar.
4. Conditions are extremely diverse, even within a village. There are several quite separate language/cultural groups; a great range in geographical conditions from semi-desert to tropical forest and mangrove swamps. In some families three wives will each cook

separately and different; in many places 4-step translations were necessary, e.g. English-French-Wolof-Serer, for mere communication.

5. There is a shortage of information on availability of clay.

6. Cooking is women's work. Building is men's. It is unclear whether stove building will turn out to be the domain of men or women. Men have less incentive to build them; women are usually more fully occupied, having less time to build them in.

7. It may be difficult to involve many Senegalese government extension agents. There is a noted reluctance for them to get their hands dirty, even for them to go out to the villages. Their status often dictates that they keep clean, stay in the towns and delegate any manual work. They tend not to be part of the life of the village, and see themselves as superior.

8. There are notable shortcomings in the preparation for the project; the social study was never started; the CUSO volunteer has not materialized; one of two PCV's assigned to the project never arrived and has not yet been replaced;* the study of vernacular stoves was never done; the vehicle assigned had by early March not even been ordered and consultants were without a vehicle for nearly two weeks of the 5-week stay.

*Neither the Senegalese sociologist nor economist promised in the AIP (pp. 58-59) had been hired. Consequently consultants were forced to use precious time doing work for which they were unprepared; assessing cooking habits and rural sociology.

METHODOLOGY AND FINDINGS

Task 1: SOCIOCULTURAL ASSESSMENT

It should be noted that any cultural interpretation based on so short an acquaintance with a country can seriously misread important factors, especially because much of our information was of necessity second-hand in the short time we had available. Obstacles to the delicate art of introducing a totally new basic technology are easily overlooked. Even from Sahelian literature one can be mislead in that Senegal is atypical of conditions in the rest of the Sahel. Our field visits covered all parts of the country with a population density of more than $25/km^2$, accounting for more than 80% of the rural population. We visited all regions except the Eastern, all major cities (Dakar, St. Louis, Thies, Kaolack, Ziguinchor) and by contrast part of the Gambia. An associated study gave us the opportunity to make comparisons with Mali, Upper Volta and Niger.

Rumors abound of vernacular woodstoves all over West Africa, some of which are allegedly in Senegal. If indeed such stoves exist it would seem wise to build on already known technology in place of attempting to introduce a completely new one. The AIP states quite clearly IPM would do a survey of such stoves by the consultants' first visit, so it is disappointing to find not only had IPM not begun the work, but not having been given a copy of the AIP, neither did they know it was expected of them.

In our field work, we found no evidence of any such stoves (except one example of a pot charcoal burner) though a much more thorough search should be made for them.

In several important respects, we found conditions substantially different from what we had been led to expect by available literature. More than anything it is wise to be cautious of statements that start with: "In Senegal..." or "Throughout W. Africa..." or even "Here in Africa..." followed by a statement on prevalent social conditions. Africa is as diverse as Europe. Senegal itself is diverse, the very villages and families all operate differently, exactly the same as we all do anywhere else. What then emerges is a picture of generalizations, from very limited field experience.

Fuel

Wood is used throughout the rural areas, though not exclusively; charcoal is also used, especially for making tea and for re-heating leftovers, a common practice. As charcoal is subsidized and very cheap (US 10¢/kg, March 1980), one can expect charcoal use to increase rapidly; it has other advantages such as smokelessness, weight and less maintenance of the fire. Even with woodfires the coals are often conserved and used as charcoal for later meals. In urban areas charcoal is already the primary fuel and as urban populations are increasing three times as fast as rural, the role of charcoal is more important than might be thought.

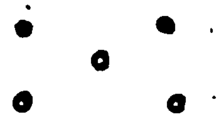
Dead wood was plentiful following the 1969-73 drought but now is in short supply, and as it is illegal to cut down living trees (which could then be stockpiled and dried before burning), much of the fuel cut is live branches cut from full-grown trees. Trees are pruned back with a machete to where branches achieve 10-20 cm diameter the prunings browsed by goats, then the bigger twigs are bundled and carried away for firewood. It seems probable that firewood is often thus burned green resulting in less heat and more smoke. Means of splitting wood are very limited so a great variety of diameters up to about 15 cms find their way to the fire, though more and more in the driest areas it is tiny twigs 2-4 cm diameter that are burned. Large trunks often go to waste for want of adequate tools to split them down to size. We were told in Volta that in some areas the settled villagers will purposefully not protect their woodlots against migratory Fulani herdsmen, who at night cut down their trees for browse. The trees once down are legally burnable yet the locals are this way innocent of illegal felling and get use of the firewood. The Fulani, being migrants, are seldom caught.

Economy is second nature and women will quench the fire with water or bury the embers in sand immediately after the cooking is through. Curiously, however, they will sometimes light a fire considerably prior to putting a pot over it. Additionally, people burn millet stalks in the dry season, until they run out, and the dung of peripatetic herders' cattle which they collect on the open land between the villages. Often millet stalks and dung are used as kindling to woodfires. Fires are used also for heating; there are sometimes ceremonial fires in the evenings; some don't use dung because it burns with an obnoxious smell. In Casamance smoke is used as insect repellent and as a curing agent for rice stored above the fireplace. Fires are commonly lit in granaries to combat insects.

Cooking

Almost all food is cooked, through custom and for hygiene.

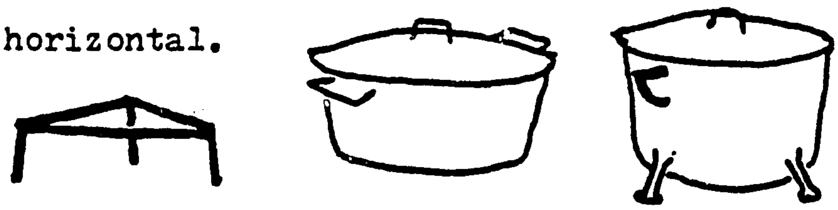
Staples are hard grains, millet and rice, which need relatively long cooking, eaten usually with a sauce of peanut butter with herb and leaf flavorings, sometimes with meat or fish. The preparation method we saw most was ingenious in its fuel economy: once the fire is going a sauce is started in the main pot. As this cooks, a perforated basin containing crushed grain is set on it, cunningly sealed at the lip by a strip of cloth wound around the space between pot and steamer. When the rice or millet is steamed, it is removed, the solids and most of the sauce transferred to another pot, and the rice added to the sauce residue for further cooking. By this means, only one pot is used for cooking. The whole proceedure takes about an hour and will usually be the day's main meal, around midday. Supper for those who can afford it may be the same warmed up, or millet pudding. Breakfast is simple, a hot drink and bread or last night's leftovers, usually warmed up. In Casamance, often several pots are used simultaneously, sometimes on an arrangement of 5 rocks, arranged like this:



<u>Pots</u>

In all the areas we studied, except parts of Casamance, traditional clay pots have disappeared in favor of Senegalese-made cast aluminum pots with straight sides tapering slightly towards the bottom. They are large: family pots 30-36 cm diameter by 15-20 cm deep are common; extra-large ones for special occasions can be 45 cm x 35 cm. Contrary to reports they are normally used with lids. Many have three short (4-12 cm) legs cast onto the base to stand them over the open fire, as there is a shortage of rock in some areas, or are set on iron triangles with feet about 15 cm high.

Usually there are two handles near the top, sometimes vertically arranged, sometimes horizontal.



In Casamance, pots tend to be much smaller: 15-20 cms in diameter, as cooking is more varied, with some small clay pots, too. Usually the smaller pots are used for rice, several simultaneously, a larger one (about 25 cm) for sauce and an earthen one for fish. Earthen pots are reputed to burn the food less easily.

Where Is The Kitchen?

Cooking is truly a moveable feast and can be indoors or out, in sun or in shade. It may move location from one meal to the next, apparently on whim though more likely shrewdly judged depending on wind direction, shade patterns, etc. Criticisms of the stove project (by white foreigners) have included the observation that a static stove will not respond to this flexibility. Even city dwellers frequently have no set kitchen and cook outside in the yard, though in Casamance cooking is often in a separate room, open at one side, built outside under an extended eave of the house. Indoor fires in millet stalk huts present a great fire hazard, which may incline cooks toward outdoor cooking.

Task 2: STOVE DEVELOPMENT

Extreme poverty, lack of tools and limited technical expertise all point in one direction: that stoves should satisfy these following criteria:

- They should be locally produced either by householders or by local specialist stove masons.
- They should be built chiefly of local materials to retain what small wealth there is in the villages.
- The materials should cost as little as possible.
- Construction should need no special tools or difficult techniques.
- They should be designed so that it is impossible to use them so as to consume more fuel than an open fire.
- Rather than being a single set design, they should respond to a set of principles so that constructors can tailor each stove to differences of cooking, fuel, climate, regional local village and household differences.

NOTE: We must beware of preconceptions of what we think a "stove" looks like. We are designing a method of using less firewood. Thus M3, the product of the first session with local people looks hardly like Western notions of a stove at all. It is uniquely a product of the needs of this culture, this village.

Stove acceptance will further depend on satisfying these criteria:

- They must save fuel so dramatically that women will want them for that reason alone.
- They must be easy to cook on without demanding special pots or requiring uncomfortable postures for tending or cooking.
- It must be clearly apparent how they function best, so that the cook can make her own decisions about regulating them.

- They should disrupt local customs as little as possible. An example: There is some debate about whether it would be possible to design a stove which will only burn smaller dimensions of firewood. Woods burn better and dry more readily if split really fine, but gathering practices and inadequate tools make splitting these gnarled tropical hardwoods extremely difficult. Smaller fuel would enable stoves to be built with built-in wasteproofing; tiny openings for fuel and smaller fireboxes which would enforce economy. Shorter fuel would enable a door to be closed on the firebox, preventing a rush of cold air which can reduce the hot air convection to the pot. Is it then justifiable to expect people to split their firewood finer in pursuit of greater efficiency?

Materials

Most stove models designed by foreigners for use in West Africa have used concrete. We carefully considered two new Voltaic stoves, the Nouna stove and the Kaya stove, both of which are concrete. They cost between 2000 and 6000 CFA, and involve formwork and steel reinforcing, additional to the cost of the cement. Similarly, stoves made of brick or steel are possible but are outside the means of most villagers and generate further dependance on outside materials.

The only tools commonly available to most families are shovels, machetes, spoons, forks and hoes; all prototypes were designed with this in mind, though IPM's trained masons have bricklaying trowels to speed their work and give them an air of professionalism.

The only local materials widely available and accessible to everyone are sand, clay, water and trees. In some areas, granaries are woven from straight wands cut from bushes, and one imported material, corrugated steel roofing, is available some places. Following the success of Lorena stoves (lorena is an integral sand-clay mix) in Guatemala, work began immediately to see if similar lorena mixes could be used here. North of The Gambia, clay exists chiefly in two forms: "bann" is a dark-colored clay precipitated in depressions during the rainy season. It forms a thin impermeable layer on the surface. "Keu" is deep-lying sedimentary material - rocklike in appearance, looking like pale buff mudstone - found usually when wells are dug. In some areas, both are found in their pure state but more often, there is an admixture of sand. Often, termite hills contain a high proportion of clay and make successful stoves. In Casamance, many different forms of clay exist, e.g. as a thin layer 1-1½ meters down in rice paddies.

Different proportions of sand:clay, ranging from 5:1 to 1:1, need to be used according to the clay's purity. It was found that most clays have good firing characteristics and bake up hard, though it seems there may be some which degrade when fired. In these areas clay would have to be trucked in. Small stoves would need about 30 kg, large ones 60 kg of clay. So, a 10-ton truckload could easily supply clay for 200 stoves - a large village.

From our experience in Guatemala and Honduras, early Lorena stoves are still functional after 2-3 years, so it seems safe to guarantee that Senegalese Lorena-types will be good for at least 12 months. Cautiously, it seems safer to tell villagers that this is a 1-year stove and to expect to rebuild it annually. If it lasts longer, that is a bonus, but this way there will be no high expectations that its design life is infinite and regular repairs can be expected at yearly intervals.

How Villagers Were Involved In Design

Following initial trials to ensure that sand-clay would be a suitable building mix, two Lorena-type stoves were built in villages, to modified Guatemalan designs, without investing much time in involving the local people in their design. 1-M1, the first, had 2 potholes; 1-M2, the second, a single hole (see Appendix I). It was clear that these were merely variations of a stove which had been developed for another culture far away and that the involvement of village people was essential in developing their own stove. Senegal needs its own indigenous stoves.

The M3 models, by contrast, were developed with villagers as a response to their own problems, in a unique way. Here is Laurence Jacobs' description of the way he worked with villagers to develop the M3 model:

> "They were already keenly aware of the amounts of wood they were using because of the energy survey being done in the village by the Peace Corps.
>
> "During an informal evenings' discussion we brought up the increasing wood scarcity. We all talked about that and women mentioned ways they used to reduce wood consumption: lids, windbreaks, putting embers out with sand. We talked about how fire heats a pot, where that heat goes, how it is lost around the sides of a fire, while making an analogy with the small lantern that was lighting the tiny hut where the fifteen of us were gathered.
>
> "The men and women said 'Yes, we lose a lot of heat around the sides of the fire.' Again they chatted about windbreaks, their problems.
>
> "At this point we passed around fired balls of Lorena... 'Where did you get this?'...'Where did it come from?'... 'Maybe we can make something with this.'
>
> "From there, they came up with the modified windbreak based on the ideas that:
>
> 1) Heat radiates in all directions from an open fire like light from a lantern.
> 2) Wind blows heat away.

3) A pot loses heat around its sides and top. "Basically what they came up with was a pot surrounded by lorena walls, a crude M3....from their idea we suggested an entrance for wood and some technical points like spacing around the pot, thickness of walls. But it's their stove now."

In the development of MX models with chimneys, a similar approach should be taken-if necessary re-inventing variants of the same stove in villages all over the country. Although M3 has no chimney, first trials indicate that it is more efficient than current models with chimneys. The sides of the pot in effect constitute the chimney interior, so heat loss from escaping hot gases is to the pot rather than being wasted up a chimney. As better insulation of the firebox is developed, we can expect further gains in efficiency.

Although smoke in houses is repeatedly stressed as a health hazard, we found in fact that with most families we visited, cooking is done outdoors, though this may be a result of smoke and hot fires in houses. Whether provision of an enclosed smokeless stove would move the kitchen indoors is uncertain. There seems to be much variation from one village to another; even within a family, one wife may cook indoors, another in the sun. Again contrary to most published work, we found women rather surprisingly cooking in the full heat of midday tropical sun, without even the shade of a tree to protect them. They do however seek out the most sheltered part of the compound; parts of Senegal can be very windy at times. There are seasonal differences too; many women who normally cook outdoors will build the fire indoors when there is rain, sometimes varying daily, e.g. indoors for breakfast, outdoors for supper. In Northern Senegal it can be chilly early mornings from December to February and it is customary at this time to build a small open fire at breakfast time, as much to warm the body as the breakfast. Introducing closed stoves would not preclude this - in highland Guatemala, we found people with both a Lorena stove and an open fire burning simultaneously, the one for warmth on cold winter mornings, the other to cook the breakfast. In Senegal this would be unusual, necessary only a few mornings in the middle of winter.

In short, M3 stoves are best suited outdoors and should be considered an interim measure for indoor cooking. It is possible that some kind of woven cowl chimney suspended from the roof could extract the smoke without reducing the efficiency, but more work needs to be done on this. Equally, M3 is a single pot stove and it might lose efficiency as a two-holer. In areas where two pots are regularly used, M3 models should be carefully tested before widespread distribution; it may be found that a chimney model which utilizes waste heat from combustion is better suited.

Where M3 stoves are built outdoors without roof shelters, they need surface protection from the heavy summer rains. One possibility is a waterproof cover of some kind. In Guatemala, varnish, house paint, cassava starch and cement all are used as protection, though cooking is usually indoors. Here IPM is testing rice-starch, cooking oil and a thin layer of cement/clay. It seems that construction of a thatched roof over the stove might solve all problems, both of sun and rain, unless there are good reasons for not doing this.

On revisiting the first batch of field trial stoves, the oldest less than 3 weeks old, we found most of them in use, some actually cooking when we arrived. None appeared to be abandoned, though 1-M1, the unmodified Lorena, seemed to be on temporary vacation.

Some of the stoves were interesting variants, one having two entrances to a single pothole, and in one village an enterprising 12 year-old had built an excellent replica and was intending to set up in business as a village stove builder.

Interest was clearly high. We heard nothing but enthusiasm. In several villages people were pestering the local PCV to build them one like their neighbors. Two women in different villages said they were using half the fuel, and though there were technical faults in some of the stoves, they were all serviceable. At Thiolam Fall, a Wolof village near Kebemer, we arrived the day of a Rural Area meeting, when chiefs of 80 surrounding villages come to meet with the chief chief, in whose compound was an M2 stove. Everyone saw the stove and there was obvious interest. We were told of the same stove that somebody's influential brother-in-law had been so impressed with that he was going to mention it to President Senghor the next week.

Task 3:
ESTABLISHING A TESTING FACILITY

IPM is an excellent choice of location for a central testing facility. It has an impressive record for technical achievement. Both Dr. Djibril Fall, the Senegalese director and M. Gerard Madon, the French engineer in charge, are enthusiastic and recognize the importance of this project. M. M'Bow, the technician/investigator who heads the testing team is inventive and intelligent; this will now be his full time work. He has been with IPM several years and is trusted and energetic. The graduate engineer from Thies originally hired for this work has unfortunately left IPM due to financial hardships.

With our arrival two masons were hired (now three), one of whom is an older man who should command better respect in the villages than the younger, more active men. One of the younger masons seems uninterested in the project, so we have recommended that he be replaced.

This basic team now understands what we are aiming to achieve and are sufficiently well organized to proceed. They know how to test clay and mixes for finish, shrinkage and firing characteristics. They know how to identify a suitable mix. They have learned the limitations of the material simply by building many stoves. Already they are innovating and testing their own ideas. By March 27, 15 stoves were built and finished, all but one tested. Some are parallels of village trial models; some are to test new ideas, both ours and theirs; some are identical pairs for testing a single variable. The teams are being encouraged to initiate their own research and are being given considerable responsibility.

Efficiency tests have started, but on so small a sample, nothing definitive can be established. Basic methods of testing have been worked out to eliminate all likely sources of error.

Tools and construction and cooking equipment are being bought as the need arises, wherever possible within the range of goods available to the rural poor. Every effort will be made to simulate rural village conditions. Monitoring equipment on the other hand is precise and highly technical. It includes digital thermometers, pyrometers, and precise measuring tools of all kinds.

Task 4:
DISSEMINATION

Several different methods could be used to disseminate information about the new stoves. If we are to accomplish a lot quickly, they fall into two main groups:

1) Diffusion by word-of-mouth and owner-building.
2) Official dissemination through existing extension agencies. This would suggest construction by specialized stove masons.

We have no way of telling at this stage which approach will yield the best results. From Guatemalan experience, although people can and do build their own Lorena stoves, a professional builder is able to create a better stove. He/she develops an adroitness of finish and a grasp of principles that is possible only with practice; often he/she is better able to build a durable, economical product.

Supply and demand theory might suggest that if the need is great enough the word will spread rapidly by relatives and friends from a few carefully placed stoves in key locations. It would be necessary only to develop a good model for home-building, introduce the concept at a few influential places, teach people how to build them, then go away leaving dissemination to pursue a natural course. The sociology of rural Senegal may however be so much centered on Dakar-village communication paths (rather than inter-village) that natural spread of ideas is now really slow. It is possible too that people's good native horsesense has become so dislodged by commercialism that only centralized promotion of a more spectacular kind can impress them. There may well be deflated value to something generated in another village, a lack of pride in rural enterprise such as exists elsewhere in developing countries.

Every experienced informant on the matter is of a different opinion. Some advised working through religious leaders - the country is 80% Moslem - "If you convince the marabouts," they said, "they only have to order it and in a few weeks everyone in the country will have one." Others suggested working through rural health clinics, using radio propaganda, or demonstration models in the National Assembly.

We are it seems in the position of a gardener who would wish to grow flowers all over a big piece of poor land. He knows that watering will be irregular, that conditions differ all over his plot; soils change, the trees throw shadows in places, there are places flooded, parts very steep. He knows his personal energies are limited and that the soil is poor all over. Any single species might be lost completely.

So he takes packets of all the most promising seeds and broadcasts them randomly all over. He waters where he can, weeds whenever there is time, throws a little compost here and there.

Some come up in sunshine, others in shade, some eventually die from drought before flowering. He stands to lose order, control, and any assurance of particular combinations. What he gains is a better chance of <u>some</u> sort of flowers, scattered irregularly but covering most conditions. Further, it is likely that the successful survivors will hybridize, throwing up a second generation containing undreamed of varieties suited uniquely to the particular conditions that prevail.

Our knowledge of conditions in Senegal is parallel to the gardener's. We know that there is great diversity and understand some of its limits. It is proposed that dissemination be tackled in as many diverse ways as possible, aiming always at village-level word-of-mouth distribution as an end result, but encouraging initially both owner-builders and the emergence of a new class of professional stove builders.

Initially in months 5 through 12, a carefully controlled experiment should be generated, where two separate approaches can be studied simultaneously. They should be evaluated at the time of the consultants' second visit in months 11-12.

Approach 1: Soft-sell, low-key, careful introduction of 1-4 stoves by a PCV in her/his village. No financial help, no outside specialists, no publicity. Careful monitoring of

(A) fuel conservation;
(B) spread of stoves within the village, with dates and who built them;
(C) spread to other villages;
(D) how the stoves are used;
(E) any innovations or changes that develop with 2nd generation and subsequent models;
(F) expressed shortcomings and ideas that villagers have to remedy them.

Approach 2: In another area but close enough to have good ethnic and cultural parallels (about 50 km would be suitable), a government agency such as MFR or PH should recruit, train and pay a 3-person mason team who work within a 15 km radius of their home base. In one village they might build stoves for anyone who asks them free of cost; in another, teach anyone who wants to learn how to build and maintain them; in a third, to build stoves for a small fee. Monitoring should be standardized with Approach 1.

Several parallel trials of this kind, perhaps with minor variations, should be run as soon as possible. It is suggested that at least 5 areas be treated this way, in separate regions of the country. The trials already operating in the Kebemer area would provide a nucleus for the first prototype. Variants could be tried on systems of payment, one team earning a flat salary, another being paid a bonus on each stove in regular use in their territory after three months. A third could be paid salary for three months as a starter, after which they would only earn bonus. This work should be started in months 5 through 7, to achieve any kind of results before the 1980 wet season. Results should form the basis for the wider extension project which will begin month 10, and should be carefully studied and published.

Some of the villages selected should be those of PCV's who are not themselves intending to be promotors, so that monitoring can be done by personnel with similar cultural prejudices.

For widest distribution as fast as possible, here are a number of directions to follow:

Government Agencies: MFR, CER, SODEVA, PH, Eaux & Forets (see Appendix III). Each of these agencies has a national H.Q. and regional extension centers. They could sponsor teaching teams, distribute literature, build demonstration stoves at their extension centers and H.Q., offer training to village masons and distribute clay to areas where it is in short supply. CER has 93 centers all over the country where demonstrations and workshops are held; there are Promotion Humaine workers in every department. Each of these agencies is interested and should be encouraged to set up a Stove Dissemination Division which would operate in the manner best suited to their system of operation. Any one of these could set up a

National Stove Corps, teams of 2-3 masons hired from rural areas to teach and build stoves within a small radius of their homes. They could be partially paid on commission by villagers. M. Mendy, the head of SODEVA has shown enthusiasm the project and is preparing to start training SODEVA's 1800 field workers in stove dissemination almost immediately. A demonstration stove was built at MFR H.Q. in Thies, and was demonstrated to a group of forty regional field officers on March 25th. MFR were impressed, having been initially dubious, and have promised their strong support in dissemination.

Peace Corps and Other Voluntary Organizations (see Appendix III)

Foreign volunteers, though numerically few, are normally well respected and have high standing in the communities they live in. PCV's are especially well-positioned to introduce stoves, as they live in villages as part of a (usually influential) family. Already PC is operating a national survey of energy-use in the home so volunteers are well versed in the concepts and needs. PC have expressed firm support and the enthusiasm of their volunteers is high, though there are only about 100 of them in Senegal.

Prevention Maternelle et Infantile (PMI)

A system of rural health dispensaries, "several hundred" of them dispersed through rural areas. They offer an educational service through Well Baby Clinics at which groups of women are taught hygiene, nutrition and cooking. Stoves at these clinics would serve the immediate function of providing a better place to teach nutrition; at the same time as interest is aroused they would be excellent center at which to teach construction methods. This might lead to stoves being built by the actual users, women, and at the same time, allow training in use and maintainence of the stoves.

Demonstration Farms and the National Research Farm

The Bambey Research Institute teaches students from villages all over the country. Working demonstration stoves could be built there and at their trial farms all over Senegal. The director, M. Mbodj, has requested that he might send promotors to learn the technology.

The Press

Though literacy is extremely low (12% of the male population, 1975 census), the daily Le Soleil is read by policy makers in the capital and other major towns. Le Soleil would give the project extensive ongoing coverage. Connections are good with IPM (they are in a neighboring building) and should be exploited. This may be of little direct help to the rural poor, but will help focus attention on the matter at administrative levels. Later, as better charcoal stoves are developed for city use, pictorial information for building them could be carried by Le Soleil to reach urban readership.

Radio

Radio is recieved all over the country and in even the poorest villages there are usually receivers. Educational programs could carry items on stoves in the local language, with stories aimed at raising consciousness that stoves are possible, easy to build and save a lot of firewood.

Famille et Development

This is a quarterly magazine read throughout West Africa. It has H.Q. in Dakar and one of its feature writers, Diana Senghor has expressed interest. They already publish an ongoing series on Technologie Appropriee and carried detailed instructions for building a Lorena stove in a previous issue. Through them, principles of stove construction could be made available through all of W. Africa, possibly in pull-out comic-book format.

Other Directions

- Demonstration stoves could be built at Touba for the big December pilgrimage which draws over a million people.
- The international Exhibition in Dakar in November will have stoves built. IPM and PC will assure that this is staffed.
- Heads of religious organizations, especially the Muslims, should be approached to make public pronouncements on the advisability of having an improved cookstove.
- Stoves could be built in the foyer of the National Assembly, as has been done in Upper Volta, with a photographic display showing them to be a triumph for Senegal.
- A national competition for stove design with substantial prizes for good ideas, the best constructed stoves, and above all, the most economical stove, could elicit interest and reward native ingenuity. This would be an easy device for centralizing information on new local developments; announcements could be carried on the radio. IPM and PCV could adjudicate, the prizes being given in the villages by the President.

THE NEXT STAGE

Already we have a basic Senegalese stove and a system for building stoves, within which variations on the basic model can be developed. IPM have a clear schedule of testing; preliminary tests indicate that the first crude models save about 50% of the fuel of an open fire. One M3 stove saved over 60% on field trials, burning dung.

The major task now is dissemination and involvement of the population, without which the project is meaningless. If this is well handled we have a potential to break new ground in rural development: stoves could be available to the entire rural population within three years. It might be realistic to aim for 80% saturation of the 4 million rural population, or 5-600,000 stoves. (See dissemination chart.) This alone would save 15-20% of the entire Senegalese energy budget, would reduce pressure on the few firewood sources existing, and substantially check desertification in the northern part. It would give short-term relief to allow new village woodlots to begin providing. Also, and in the long run perhaps more importantly, it would give incentive for the people to remain woodburners instead of switching to charcoal, which though subsidized, uses more wood to produce.

As the urban population grows faster than rural (6% versus 2%) the proportion of the population burning charcoal will increase rapidly. By 1985 more wood will be utilized in charcoal production than will be burnt in open fires as fuel. By 1990, it will be twice as much. Even the introduction of high-yielding kilns, if it happens fast enough, will only raise the efficiency of production to about

35%. The new kilns will make charcoal available that uses only about twice as much wood as firewood, as opposed to three times or more at present. We must in other words immediately turn our attention to improving existing charcoal stoves, designing more economical models and trying to prevent more people switching to charcoal.

Simple woodburning cookstoves with chimneys will help; one attraction of charcoal is its relative smokelessness. Lifting the present subsidy on charcoal is essential; a charcoal tax would be more appropriate. But charcoal use is likely to continue, especially as closer sources of firewood are eliminated, and transportation costs make wood haulage to the cities non-competitive.

Conclusion : Work should start immediately at IPM on improved charcoal burning cookstoves.

WORK AT IPM (See also Appendix VI)

Realistically, work will slow down considerably July through September, the second phase running from mid-Spetember on. In phase I a substantial understanding of the stoves should be achieved, so that dissemination work can continue full-scale after the rains. By early July IPM should have published material on the following:

1) M3 chimneyless stove: results of fuel trials; summary of construction principles; recommendations on mode of use for best efficiency; possible adaptations.

2) MX, a selected chimney single-burner: results of fuel trials: effect of dampers.

3) Basic principles of improved charcoal burning stoves.

Work should have started on improved charcoal stoves, insulation materials for fireboxes, lids, covers, hotboxes, etc. and the use of terra cotta for portable stove manufacture. A mobile training team should be available to give demonstrations, field workshops, etc. at short notice.

Phase II will continue much of this work, especially that on charcoal burners; continue testing for fuel efficiency, improving further M3 and MX. Additionally, as more trials are built in the countryside, IPM should evaluate not only performance but the social effect of different distribution systems. At consultants' second visit, Nov/Dec. 1980, decisions will be made with IPM as to how dissemination should proceed. Increasingly, IPM will be needed to answer inquiries from stove builders and developers all over the country; more staff may be needed to provide better service.

PC COORDINATOR'S WORK (See also Appendix VII)

The PCV's work, like IPM's, falls into phases I and II. During much of phase I, she will be heavily involved in language training. Workshops will be held during these months for P.C., CER, MFR and PH, to train trainers. She will also coordinate information coming in from PCV's who already have stoves in their villages and liaise with IPM at bi-weekly meetings, held alternately in Thies and Dakar. In phase II, by which time she should have at least one full-time colleague, she will work teaching workshops, locating vernacular stoves which may exist, and compiling information on innovations, trials of new stoves, how well dispersal is occurring, and new information available from international sources through Aprovecho.

AID COORDINATOR'S WORK

AID should provide liaison, check-ups and encouragement to ensure that every group working on the project has the support it needs. Initially in phase I, the PC coordinator will need considerable help.

It seems likely that additional funding will be necessary to complete the project. AID should make sure this funding is available to bodies who have need of it. Relations with the press and the government may be enhanced with AID assistance: introductions, recommendations, etc. Other AID projects in Senegal are closely linked and should be integrated wherever possible (firewood plantations, village woodlots, rural clinics, rural women's development, etc.) using other projects to help introduction of stoves into the more remote rural areas.

The success of the project hinges directly on AID's ability to provide continuity of coordination in the early stages.

Specifically, AID should ensure that IPM's work is running on schedule, with on-site inspection of IPM's work at monthly intervals. The purpose of these visits is to ensure that any obstacles to the smooth running of the project would be identified in advance and headed off before IPM has to deal with them. In addition, AID's coordinator should pursue all government and other agencies involved in dissemination, to facilitate funding and contacts where they are required to carry out the work.

CONSULTANTS' WORK

Stove consultants' second visit should be immediately after the 1980 wet season, not in the middle of it as suggested in AIP.

At that time several jobs should be done:

1) Consultants should evaluate all IPM testing to date and determine with IPM the direction of further research. Ongoing work by Aprovecho in Oregon will by then have developed more prototypes. These can be used to corroborate IPM's results.

2) PC's role will then be settled. Consultants, together with the PCV should inspect field trials, making comparisons between naturally-spread designs and those promoted by agencies.

3) The work of government agencies should be evaluated. Proposals should be made as to which would benefit from outside funding. Some agencies may need technical help which is not available from IPM or PC.

As it was evident from early on that a huge volume of work would need to be done during consultants' first visit, Laurence B. Jacobs of Aprovecho Institute joined Ianto Evans and Elisabeth Gern, at no expense to USAID. Immediately on arriving in Senegal, the advisability of this move was proven, when it became clear that none of the promised preparation work had been done. In fact, without Mr. Jacobs our task would have been impossible.

It is proposed that in the future, a team of three consultants from Aprovecho be employed, as the efficiency of this approach has been amply demonstrated and considerable logistic strength would be lost if one member of the team were not able to come.

The worth of a Senegalese sociologist and economist to this project diminishes as time proceeds. It is recommended that their work be carefully considered at this stage, whether in fact their services are not already too late to be of value.

FURTHER RECOMMENDATIONS

1. In pursuit of this study, it became clear that the problem is equally bad with charcoal burning stoves as with firewood; that by 1985 more than half the wood cut will be for charcoal, by 1990, twice as much. Work should begin immediately on improved charcoal stoves, and on reducing the demand for charcoal by every conceivable means.

2. Initial response to this project is unusually encouraging. Heavy publicity should be given to it by all agencies. This is a pilot scheme which, if successful, could be a model for all of Africa.

3. AID should make funding available to government, or private agencies needing support for the necessary extension work.

4. PC should allocate at least one, possibly two, full time workers to form a team with Karen Nelson, as was planned in the AIP. The work is excessive and unwieldy for a single person. French speakers are essential.

TECHNICAL REPORT I : Mixes

Materials

All stoves were constructed with a "lorena" type sand-clay mixture. Normally, for construction purposes, sand is hauled from beaches as the wind-formed rounded grains of inland sand constitute a poor aggregate for concrete. With distance from the coast the cost increases rapidly, so only the rounded sand is available to most of the peasant population. We tested both sands to see if common inland sand is in any way inferior.

Three specimen clays were tried:

A a fine-quality grey potter's clay, purchased from a local pottery;

B a red laterite clay, fairly pure, found among laterite deposits on sea-cliffs near Dakar;

C the common sandy clay of the Cap Vert peninsula subsoil, randomly taken from foundation diggings.

Method

Bricks 25 x 10 x 5 cms were carefully cast, of mixes at each proportion, as shown below:

<table>
<tr><th>MIX</th><th>1:1½</th><th>1:2</th><th>1:3</th><th>1:4</th><th>1:5</th><th>1:6</th></tr>
<tr><td>CLAY B:
SEA SAND</td><td colspan="3">- - - - cracks - - - -</td><td colspan="3">- -surface crumbly- - -</td></tr>
<tr><td>CLAY B:
LOCAL SAND</td><td colspan="3">- - - - cracks - - - -</td><td>GOOD</td><td>GOOD</td><td>too crumbly</td></tr>
<tr><td>CLAY A:
LOCAL SAND</td><td colspan="3">- - - - cracks - - - -</td><td>GOOD</td><td>GOOD</td><td>too crumbly</td></tr>
<tr><td>CLAY C:
LOCAL SAND</td><td>cracks</td><td>GOOD</td><td colspan="2">too crumbly</td><td colspan="2">untested</td></tr>
</table>

Conclusions

1) Sea sand is slightly coarser and gave a crumbly softer finish. Otherwise it seems similar.

2) Clays A and B being purer needed considerably more sand to prevent cracking (1:4 and 1:5 mixes) than local clay which already contains much sand and worked best at 1:2.

3) Mixes at 1:6 give too crumbly a finish.

4) The purity of Senegalese clay varies considerably, so should always be tested by making test bricks. We would recommend 10 x 5 x 50 cms minimum; ours were too short to show cracking easily.

Model No. 1 was at 1:4 mix of clay B:local sand. There were tiny superficial cracks. Models No. 2 and No. 3 were of clay C:local sand at 1:1. Both cracked badly. Model No. 4 and subsequent tests at IPM were standardized at clay C:local sand at 1:2. There was no appreciable cracking under normal conditions of use.

TECHNICAL REPORT II : Heat Stress Cracking

It was noticed that many of the early field trials stoves cracked. As it was not clear whether these were shrinkage drying cracks, heat stress cracks in dry stoves, or uneven drying due to premature use before they dried out, we first eliminated the shrinkage possibility. By adjusting the mix, it was shown to be easy to keep stoves intact until they were first fired. Stoves still developed cracks, however, so two identical trial models were built to test for whether heat-stress cracking is inevitable, or the result only of premature use.

The Test

Models No. 8 and No. 9 were built the same day, of the same mix, of the same dimensions by the same team. Model No. 8 was allowed to dry thoroughly for 48 hours in full sun, low humidity and a strong breeze. Model No. 9 was fired up immediately after finishing, while still damp.

Results

Stove No. 9 developed several shallow radial cracks immediately; on a second firing two days later they did not enlarge or extend. Stove No. 8 did not crack at all.

Conclusion

If the mix is correct and no structural weaknesses exist, a stove which is allowed to dry slowly before use stands a better chance of not developing heat-stress cracks.

TECHNICAL REPORT III : Chimneys

A search was begun for suitable materials and construction methods for chimneys. The outline findings were as follows:

Domestic chimneys are virtually unknown in Senegal so no processes have evolved for their manufacture. Metal ready-made chimney pipe is not readily available; nor are ceramic sewage pipes, terra cotta drainpipes or bamboo stems. In Upper Volta chicken wire reinforcement has been used experimentally to form ferro-mud tubes but the cost is prohibitive.

To be effective, chimneys must usually be at least 1.5 m high with a 10 cm internal diameter, though to clear roofs they sometimes need to be up to 2 or 3 m.

Early M2 field models used corrugated steel roofing, flattened, then rolled with an overlap and wired together to form tubes 10-20 cm in diameter. They appear to work reasonably well, but depend on a source of unwanted steel, a commodity not always on hand.

Experiments were made with building up a freestanding Lorena chimney (fig. 1) but structural limitations would make it difficult to extend it much more than 50 cms.

An improvement was made using square Lorena blocks 10 cm thick and 30 x 30 cms, formed in a wooden mould, using a 9 cm milk can to form a hole (fig. 2). The blocks have great strength when dry and can be easily mortared together to form a stack. The outside can be plastered with the same mortar and smoothed to give the appearance of a monolithic masonry stack (fig. 3).

For speed of construction, a circular mould was found to be better, 15 cms deep by 25 cm diameter (fig. 4) using the same 9 cm can for the hole. This was formed of a strip of scrap steel sheet 15 cms x 90 cms, welded together, though a rolled overlap joint would do equally well. This quantity of scrap should be available almost everywhere.

Finally a similar mould was used as a continuous form, lifting the mould and ramming the mix into it simultaneously (fig. 5). Care must be taken to allow lower levels to dry or it loses stability, but this may be the most promising approach for a team of professional stove builders.

Hybrid chimneys could also be considered where for instance there is limited steel, raising a Lorena block chimney part way, then finishing it with steel, particularly if the upper parts need to be weatherproof. In this case, a simple rain-hat should be used.

FIG. 1

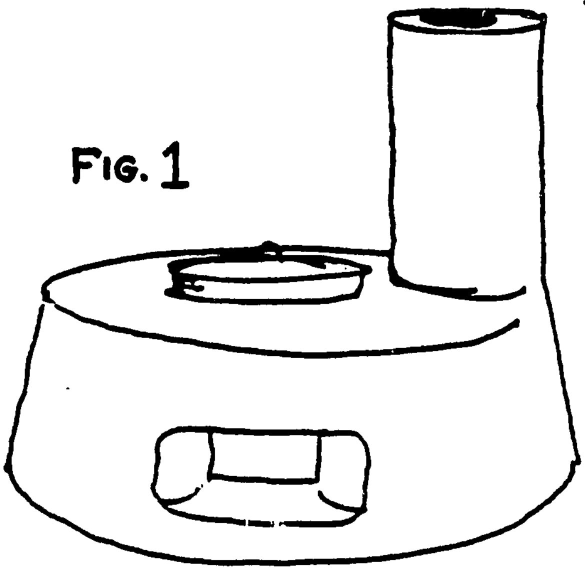


FIG. 3

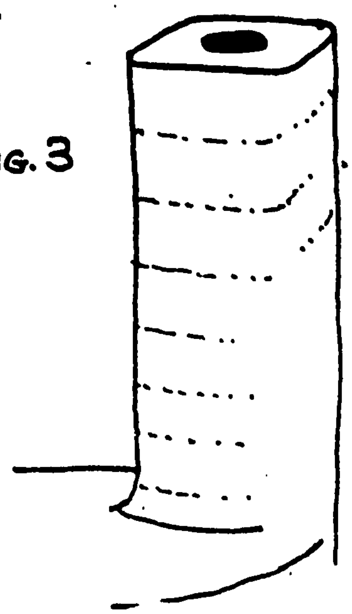


FIG. 5

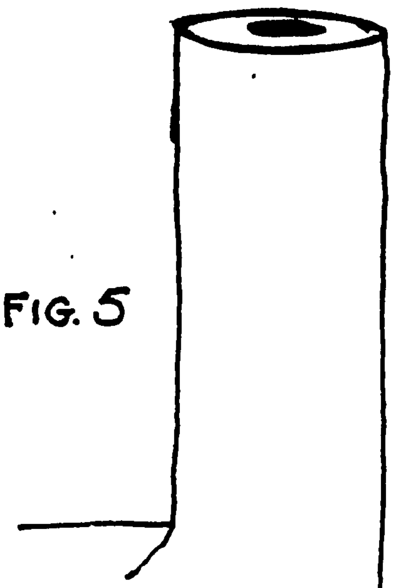


FIG. 2

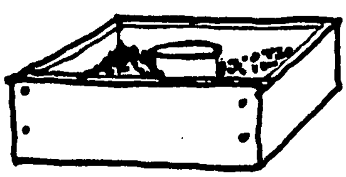
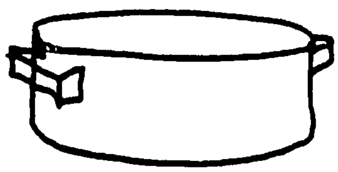


FIG. 4



TECHNICAL REPORT IV : Fuel Consumption Trials

Fuel consumption testing was carried out three ways simultaneously:

1) Field trials by Peace Corps, in villages.

2) Theoretical efficiency tests at IPM.

3) Fuel consumption tests at IPM.

1. PC personnel are already involved in PC's national Renewable Energy Study and are familiar with the principles involved. Measurement was made of the fuel use without a stove, then later with a stove, weighing fuel with a spring balance. Both wood-burning and dung-burning families experienced notable drops in consumption, from 40% to 60%. The first prototype charcoal burner showed similar economy.

2. This was the standard test for percentage of heat reaching the food to be cooked: 2 kilos of split firewood are used to boil 4 litres of water, leaving the pot uncovered. Knowing the calorific value of the wood, the initial water temperature and how much water boiled away, an assessment can be made of how much heat actually reached the water.

3. More realistically, consultants with IPM designed their own test for how much firewood it would take to cook an average meal. 4 litres of water are brought to the boil, from air temperature, and kept boiling continuously for one hour, simulating the average time spent cooking one meal. The pot lid is kept on, opening the lid every few minutes to check that it is still boiling (this represents actual conditions when the cook stirs the pot). If boiling stops, the time is measured and it is kept boiling that much additional time at the end of the hour. The amount of wood to maintain boiling is measured.

Despite technical imprecision this test does indeed simulate real cooking conditions, giving a much better picture of fuel efficiency under field conditions. To date, too small a number of tests have been conducted to cite quantified data, but a pattern is clear: stoves use less fuel than open fires (though one stove was tested which uses more fuel, so good stove design is critical); chimneyless stoves use less fuel than those with chimneys. Tests continue. A full technical report will be issued in due time.

APPENDIX I : Field Trials

All trials built 20 February-18 March, 1980
Information current, March 24, 1980

Village of Dioungo; Dept:Djourbel; Region:Djourbel

* 2-hole Lorena-type model 1-M1, dampers and chimney, 3:1 mix.
  Bad crack at first firing, later repaired. No follow-up.
  (Builders: Drew Lent, PCV; Laurence Jacobs, Aprovecho)

Village of Keur Massamba Niang; Dept:Bambey; Region:Djourbel

* 1-hole no chimney model 1-M3; developed with villagers
  Minor cracks; in daily use.
  <u>Economy</u>: 4 kg wood/day previously, now 3 kg.
  (Builders: Jan Moses, PCV; Laurence Jacobs, Aprovecho)

* Copy of 1-M3 above; 2 fireboxes connected.
  (Builder: local villager)

Village of Thiolam Fall; Dept:Kebemer; Region:Louga

* 1-hole chimney model, 2-M2; dampers, recycled roofing steel chimney, 3:1 mix.
  Operates very efficiently; cook manages dampers well.
  <u>Economy</u>: 8 kg/day previously, now 3½-4 kg.
  (Builders: Rik Mead, PCV; Laurence Jacobs, Aprovecho)

* At least 4 copies of 2-M2 above, built by villagers, some without help

* 1-hole no chimney 3-M3
  (Builders: Mead and Jacobs)

Village of Loro; Dept:Sagata; Region:Louga

* 1-hole chimneyless 4-M3; waist level, against a wall, 4:1 mix.
  <u>Economy</u>: 9-10 kg/day previously, now 4 kg.
  (Builders: Jane Schlendorf, PCV; Laurence Jacobs, Aprovecho)

Village of N'gogom; Dept:Bambey; Region:Djourbel

* 1-hole chimneyless 6-M3, 2 entrances.
  In daily use though 3 major cracks.
  <u>Economy</u>: 3½ kg millet stalks + 7 kg dung previously, now 3½ kg wood only.
  (Builder: Cheri Lockett, PCV, copying 1-M3)

APPENDIX I : Field Trials (cont.)

Village of Diou Koul; Dept:Kebemer; Region:Bambey

* 1-hole chimneyless 5-M3, 1:3 mix.
  In use when inspected, "uses less fuel, boils faster", owners very happy.
  (Builders: Douglas Stone, PCV; Laurence Jacobs, Aprovecho)

City of Bargny; Dept:Rufisque; Region:Cap Vert

* 1 chimneyless 1-hole stove, M3 type, adapted to charcoal burning.
* 1 chimney stove for charcoal burning
  (Builder: Thomas Hobbs, PCV)

Headquarters of Maison Familiale, Thies

* Institutional model M1, Lorena-type 2-burner, chimney.
  Not yet in use.
  (Builders: Elisabeth Gern, Aprovecho; Moustapha and Malon, IPM)

Catholic Mission, Bambey

* Institutional model M1, Lorena-type 3-burner, chimney
  Not yet in use. Very large: 1.4 m x 1.4 m, square.
  (Builders: Laurence Jacobs, Aprovecho; Al Harti Sow, Promotion Humaine Diourabel; several helpers.)

Village of Tiombe; Dept:Gandyaiye; Region:Sine Saloum

* 1-hole M3 type, no chimney
  This is a village of potters, women.
  (Builders: Elisabeth Gern, Aprovecho, etc.)

* 2-hole chimney Lorena-type M1, for burning charcoal, 3:1 mix.
  (Builders: Gern, etc.)

Village of Rao; Dept:St. Louis; Region:Fleuve

* Chimneyless 1-burner M3 type
* Chimney 1-burner M2 type
* Chimney 2-burner M1 Lorena type
  No data available as yet. Stoves will be used for nutrition training by CER.
  (Builders: Jacobs, Aprovecho; 15 PCV, local CER head.)

APPENDIX II : Technical Information Form

For use by PCV's and other fieldworkers.
To be returned to Karen Nelson, Peace Corps, Dakar

Researcher's name: ______________________ Date: ________

1. Village, department ________________ Indoor/Outdoors? _____
   Date built? __________ Working since? __________

2. Who built it? ____________________________

3. What design? (drawing with dimensions below) ________________
   How was the design generated? __________________

4. How big is the family? __________________________

5. How far did the clay come from? __________ What mix was used? __________ What difficulties in construction? __________

   How long did it dry? __________ Did it crack? ______ If so, how much? ________ What innovations were tried? ________

6. What fuel is used? _______ At what daily cost, or how long to gather? __________ Does fuel vary seasonally? __________
   How much fuel/day was used 1) before stove? ________ 2) now? ________ Has the stove changed the type of fuel used? ________

7. How often is it used? __________ How many different sized pots are used? ______ How big? __________ Is each pot hole fully used? ____________

8. How long did it take to get used to? ________ Do they use the dampers? ________ Do they have clever tricks to save fuel? ____

9. What does the cook like about it? __________________
   What does the cook dislike about it? __________________
   How would you remedy the dislikes? __________________

10. Anything else? ______________________________

Drawings:

APPENDIX III : Agencies and Persons Involved in Dissemination

A. Agencies contacted which have indicated enthusiasm

AGENCY	CONTACT PERSON(S)	POSITION
Institute de Physique et Meterologique (IPM) Now CERER	Gerard Madon Djibril Fall	Senior Engineer Director
Maisons Familiales Rurales (MFR) Formation Technique Femenine	M. Dhiediou Mme. Josephine N'Diaye	Director Head
ENDA	Jaques Bougnicour	Director
SO DE VA	Roger Mendy	Responsable, Milieu Rural
DIPT	Ibrahima Cisse	Assistant to Head
Centre National de Recherche Agronomique, Bambey	M. Mbodj	Director
Prevention Maternelle et Infantile/ENDA	Dr. Robinot	
Ministere de Developpement Rurale et CILSS	M. Mbacke	CILSS Representative
CER, Rao, St. Louis	Malick Gueye	Chief of Teaching

B. Other organizations in Senegal which should be approached

AGENCY	CONTACT PERSON(S)	POSITION
Enseignement Moyer Practique (Education)	Yaya Konate	Director
ONU/PNUD	Martial Boujasson	Engineer
Centres Regionaux de Developpement (CRD)		
Centres d'Expansion Rurale (CER)	Ouseman Samb	I/C Animation
Condition Femenine	Idrissa Didp	Head of Studies
UNICEF	M. Audat Mr. James Moore	W. Africa Rep. Program Administrator

APPENDIX III : Agencies and Persons Involved in Dissemination (cont.)

AGENCY	CONTACT PERSON(S)	POSITION
Caritas	Frere Picard Adrien Diaw Pierre Kadebe	
Eaux et Forets	M. Kone El Hadj Sene	Sub Director Director

APPENDIX IV : Draft Teachers' Guide for Improved Stoves

As much as people need to economize on firewood, Senegalese peasants have a need to be respected as intelligent individuals capable of inventively solving their own problems. Technologies introduced from outside have a bad record of acceptance, so whenever possible involve the village people in a process of solving the problems they see in their own lives. You can offer technical advice, systems for doing things that you bring from other places, but you are mainly a mail-carrier, never an overseer; and you can't be expected to know more about their problems than they do.

Simple stoves are a rare example of a well-proven simple technology that improves the quality of life without known deleterious side effects. Here are some guidelines on how to introduce them to villagers.

The location for your first model is important. Choose the house of an important family, the rural clinic or the community meeting place. Make sure it will be used regularly by ordinary people. It is not just on display.

Then get together with people informally, ask about firewood. Is it hard to get? How much does it cost? How long does it take to collect? Talk about why heat radiation is lost on all sides of an open fire; then ask about wind blowing the heat away. Ask how people economize on fuel; they may use windbreaks, potsherds stuck between their three rocks. Ask how they think they could stop the heat escaping.

Together you can come up with ideas. They may be stuck for materials to build with. So perhaps you show a sample of a lorena mud-sand mix, suggest you could use something like that. You can explain that stoves are made of it in other places and that if they wanted, you could teach them how to construct one, it's really easy.

When you come to building it, be open to <u>their</u> ideas. These things are pretty new and <u>we</u> certainly don't know all the answers. Try unlikely ideas, there's little to lose. You'll find that the people are developing their own stove, to meet their unique conditions and maybe you can name it after their village. Much variation is possible and you can outline the principles that we know work, rather than giving rigid instructions.

It will need to respond to cooking. Ask what they cooked today, yesterday, and how many times a week is this dish used? Is it the same all seasons? What else do they cook? How big are the commonly used pots? Do they use more than one simultaneously? How big is the fuel, is it always wood or do they burn dung, agricultural wastes, charcoal?

<u>PRINCIPLES</u>

* Enclosure prevents radiation loss. Non-metallic enclosure reduces conduction loss.

* Smoke takes heat away; the more you can pass the smoke around the pot before you lose it, the more heat you will gain.

* Waste heat can be used to warm water, pre-heat a second pot or if stored, perhaps to cook another meal.

* The faster you bring food to the boil, the less heat you're likely to lose, but once it is boiling you can't speed cooking by adding more fuel. Boiling is the same temperature whether it is 'fast' or 'slow'.

RULES OF THUMB FOR CONSTRUCTION

* Make the firebox walls at least 15 cm thick, or ½ the diameter of the pot.
* The firebox should be the same width as the pot.
* The pot should sink into the stove, leaving at most 5 cms exposed.
* In stoves with chimneys, pots should fit tightly at the top, loosely below.
* There should be 10-15 cms depth beneath the pot, less if you use charcoal.
* Stoves work better if you can control the burning by damper doors.
* Outdoor stoves need to be protected from rain.
* Baffles beneath pots (chimney stoves) should rise to within 1-2 finger thicknesses between bottom of pot and top of baffle.
* In multi-pot stoves, set the pots close together, in series, not parallel.

OPTIONS AVAILABLE

* Stoves can be built any height, to suit cook.
* Outdoor stoves work well without chimney, indoors a chimney takes smoke away. (For insect control, allow stove to smoke for awhile every two days.)
* If you have sufficient materials, an extended stove surface provides table space.
* 1, 2 and 3-burner stoves all work well, but don't build more than you normally use, or fuel is wasted.
* In permanent large chimney models, a fixed pot can be set directly before the chimney, to provide hot water.
* A base can be built of brick, blocks, rock and mortar, tree stumps, etc.
* A thin cement coat gives a hard, durable finish.
* A removable iron grate adapts a wood stove to charcoal.

SPECIMEN MODEL

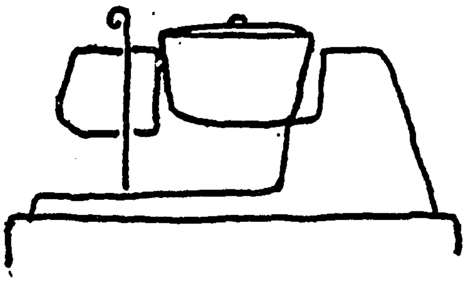
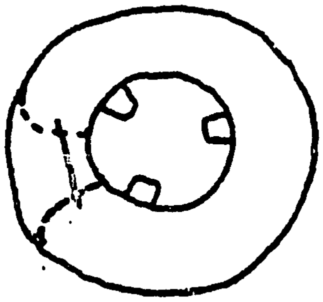
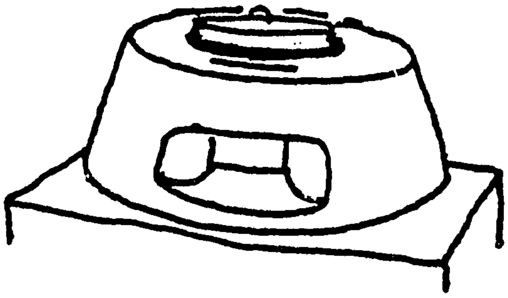
You will need a shovel, sieve, big metal spoon, machete, and some board scraps. Clay comes in many forms. Ask the locals. Bann from depressions, and Keu from wells both work well. If it is pure you will need about 1:4 or 1:5 clay to sand, impure clay 1:1 to 1:3. Make test blocks, 50 x 10 x 5 cm, see if they crack. Use the clayiest mix without cracks. Here's where a little experience helps. If your stove cracks, too much clay; if the surface rubs away, too much sand.

Just a few clays don't fire at all. So make a couple of 3-5 cm balls of pure clay and fire them first. They shouldn't crumble, or your firebox won't hold together.

Pound and sieve your clay. Mix clay/sand dry, then add water until it will just form a ball 6-8 cm. Throw ball in the air; catch it. It should hold together. If it deforms, too wet; if it shatters, too dry.

Now build up your stove. First, dig down to a firm base, soak and level it, build up brick/block/rock base to the right height. Use the mix carefully; pack it tightly. Use a board against the edge to contain it while you pack, tapping down firmly with a piece of wood; the size of a hammer handle is perfect. The pot can be used as a form to make a central hole, raising it up as the stove grows.

Cut out the inside carefully, leaving space for one finger at the front, two at the back of the pot. Build up three pillars as shown, imbedding a fist-sized rock at the top of each to support the pot. Cut the slot for the damper door <u>before</u> you cut out the entrance, making it 4 cm wider than the entrance tunnel. Then carve your entrance tunnel, flaring the outside of it, to improve its wind-catching abilities.

Finishing is done immediately by burnishing it with a spoon, rubbing it to achieve a smooth finish, inside and out. Sharp edges are difficult, round them off with a wet cloth.

Let your stove dry out adequately: 2 weeks (though outdoors in full sun, it may dry faster). Then fire it up, small fires at first, bigger later.

DIFFICULTIES

* Build your stove all in one day, or a drying crack may result along the level between layers.
* Small cracks can be moistened and repaired with the same mix.
* If the surface is too sandy, try a coat of cement, thin clay, paint, or varnish.
* Be inventive, try new ideas and feed your results back to your coordinator. This is a very new technology, at a stage where anyone with the time to try variations is likely to come up with original information.

APPENDIX V : Calendar

	IPM/Gerard Madon	Dissemination and Field Tests / Karen Nelson
MARS	M3 model without chimney tried and approved Basic prototypes developed	
AVRIL	Collect comments on first field trials; re-design accordingly Improve M3, build good specimens Top Brass meeting IPM/Press conf.	Locate vernacular stoves existing Build demonstration stoves in key place Teach workshops PC, MFR, CER, etc.
MAI	Select chimney model, publish it (MX) Hire a potter Begin work charcoal stoves Finalize chimney model MX	Train a corps of teachers
JUIN	Press conference MX Work on insulation materials Work on lids, covers, hot boxes, etc. Publish guide to construction including photos of many specimen stoves	Send out teaching corps, arrange more workshops
JUILLET AOUT SEPT	TARGET LATE JULY 100 STOVES IN FIELD Begin work tea stoves, restaurant stoves	
OCT		
NOV		Be at Touba pilgrimage
DEC	Increasing work to answer questions from field developers, PC, etc.	Be at Dakar Exhibition

(x10) TARGET 1980 1000 STOVES RURAL
100 STOVES URBAN

(x25) TARGET 1981 DEC 25,000 STOVES RURAL
5,000 STOVES URBAN

(x20) TARGET 1982 DEC 500,000 STOVES RURAL
100,000 STOVES URBAN

TARGET 3 YEARS (March 1983) 600,000 RURAL
150,000 URBAN

APPENDIX VI : IPM Work Schedule

PHASE I : April-July 1980

1. Work still to do on M3 no-chimney model:

    - Tests by cooking, with local women
    - With and without damper door
    - Depth of firebox
    - How to make potrests? Rocks, metal?
    - Adapter for charcoal use
    - Size of fuel entry
    - Develop a 2-hole no-chimney model

2. Build permanent raised base @ 60 cms.

3. Develop MX chimney model:

    - Chimney height and damper
    - Depth and shape of firebox
    - Interior barrier shape
    - 1 or 2 potholes? We need a 2 or 3 hole stove for Casamance.
    - Try a metal grate
    - Cooking tests with local women

4. Publish interim picturebook--various models.

5. Develop cheap, available insulation for firebox:

    - Peanut shells
    - Charcoal
    - Chopped straw
    - Coconut fiber, etc.
    - Test thermal conductivity, efficiency test stoves with/without it
    - Draw heat transfer profiles through stove blocks

6. Begin work on improving charcoal stoves:

    - Fourneau Malgache with clay liner, raised sides
    - New pot charcoal stoves in terra cotta

7. Covers, insulating lids and hotboxes.

PHASE II : After August 1980

1. Field trials of improved charcoal stoves--training of manufacturers, potters, etc. Publicity.

2. Increasing testing for other agencies as stoves spread.

3. Development tea stoves, restaurant stoves, etc.

APPENDIX VI : IPM Work Schedule (cont.)

ONGOING PROJECTS :

- Fuel efficiency tests on all models, including those developed *en brousse*.
- Develop better tests for mixes and clays: finish, cracking, firing tests.
- Test fuels, e.g. wood, millet stalks, dung; adaptions needed for these fuels.
- Train a mobile team of master stove masons who are available for demonstrations, training workshops, answering questions, teaching use of stoves.
- Develop and test waterproofing for outdoor stoves; try cement, starch, flour and glue.
- Maintain display of a range of models, labelled showing the differences.
- Arrange press conferences, publicity and press releases.

APPENDIX VII : PCV Work Schedule

PHASE I : April-July 1980

1. Write and illustrate trainer's manual:

   - Completion by end April

2. Arrange bi-weekly meetings with IPM, alternately Thies/Dakar.

3. Set up major information meeting between all PC personnel with trial models. May or June.

4. Organize training workshops in stove construction/dissemination/use for new PC trainers:

   - PC inservice volunteers
   - Maison Familiale
   - CER
   - PMI clinics
   - SODEVA

5. Ensure that demonstration stoves are built in key locations in government buildings. PC headquarters foyer.

6. Maintain a file record of all trial models with full data. Distribute Technical Data forms and ensure their collection. Make this information available to IPM and anyone doing stove work.

7. Maintain liaison with all voluntary agencies who can promote stoves, arrange training for their personnel. Government agencies also.

8. Target at least 100 stoves on field trial by early July; then rapid dissemination to 1000 by December. This will necessitate training at least 100 trainers by early July.

PHASE II : After August 1980

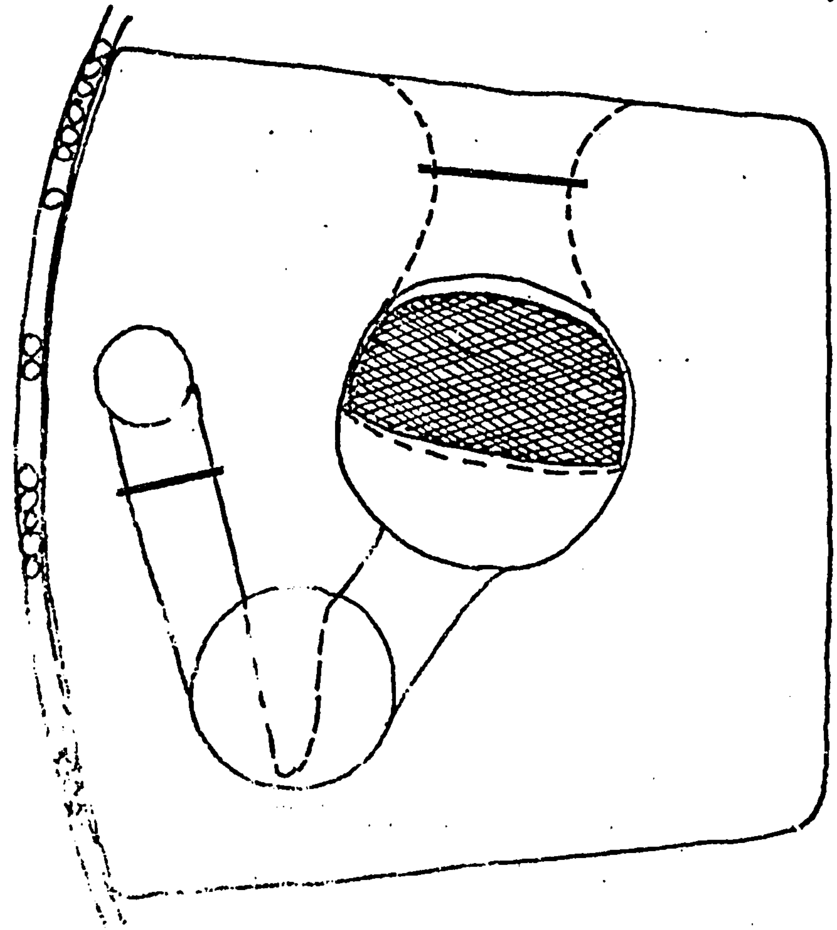
The goals for Phase II will be worked out in association with IPM during Phase I.

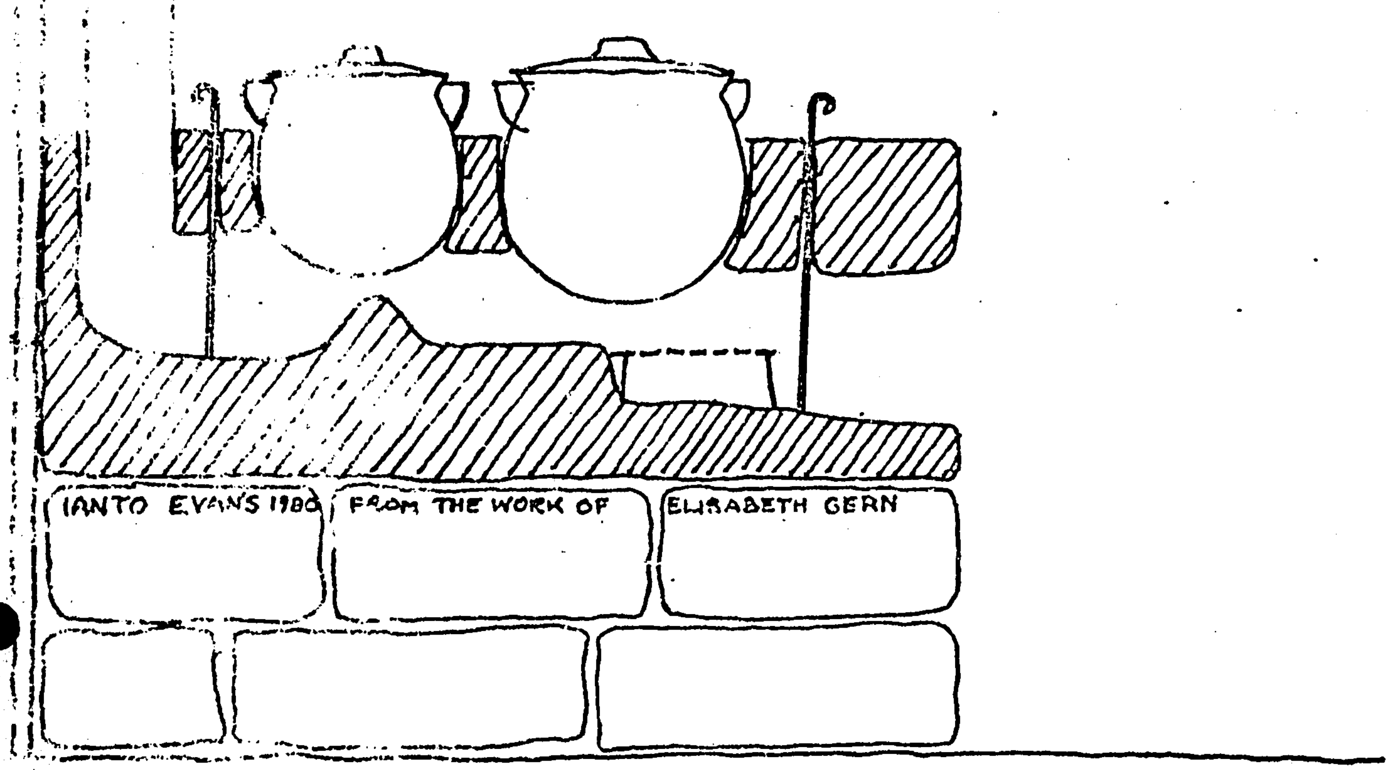
M1 TYPE STOVE #3

VILLAGE: TIOUMBE

MIX 1 CLAY TO 4 SAND AT BASE, THEN 1:3

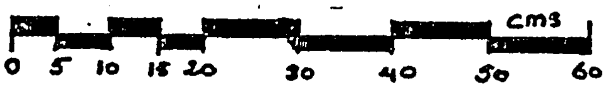
BUILT: 12 MARCH 1980; ADAPTATION FOR CHARCOAL (SEE METAL GRATE)

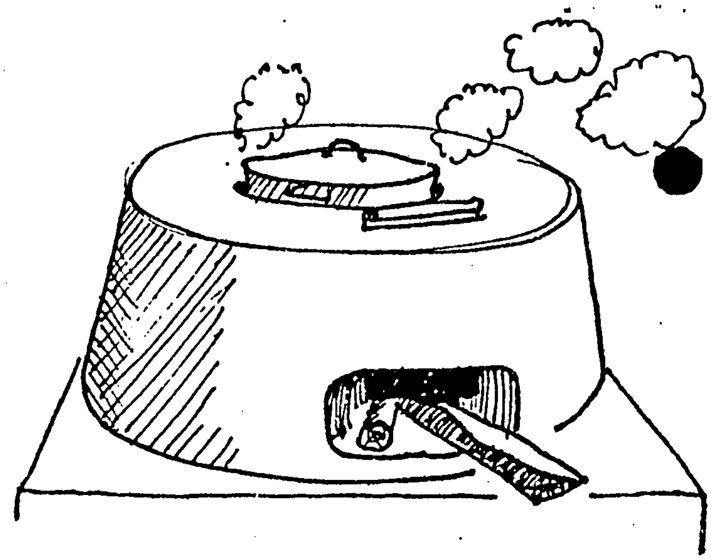


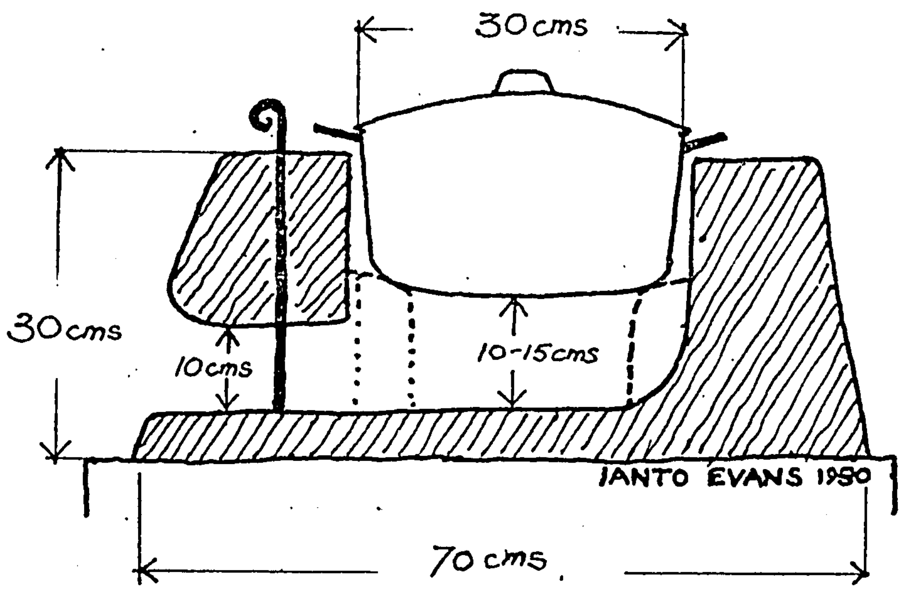


M3 TYPE STOVE

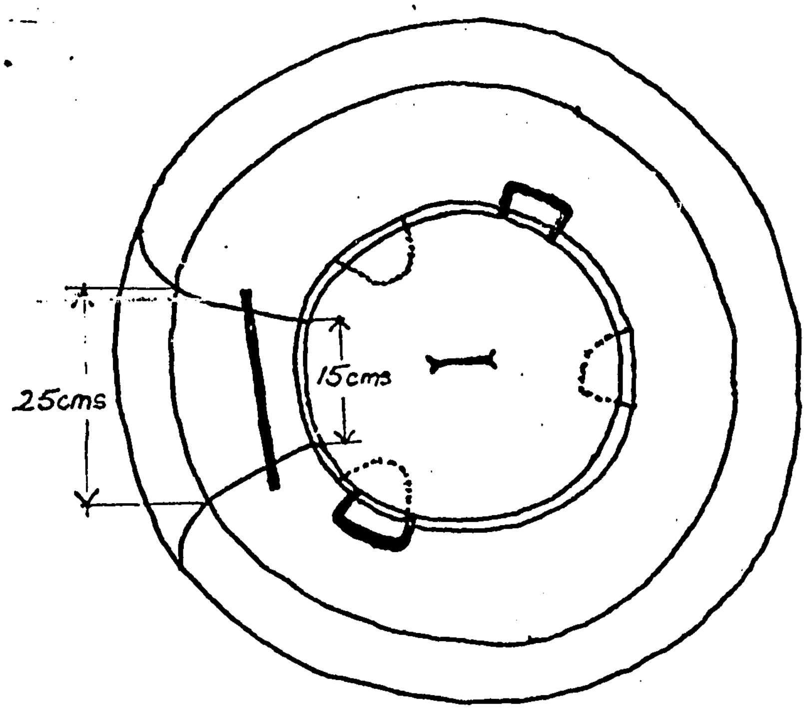
"THE LOUGA STOVE"







SECTION

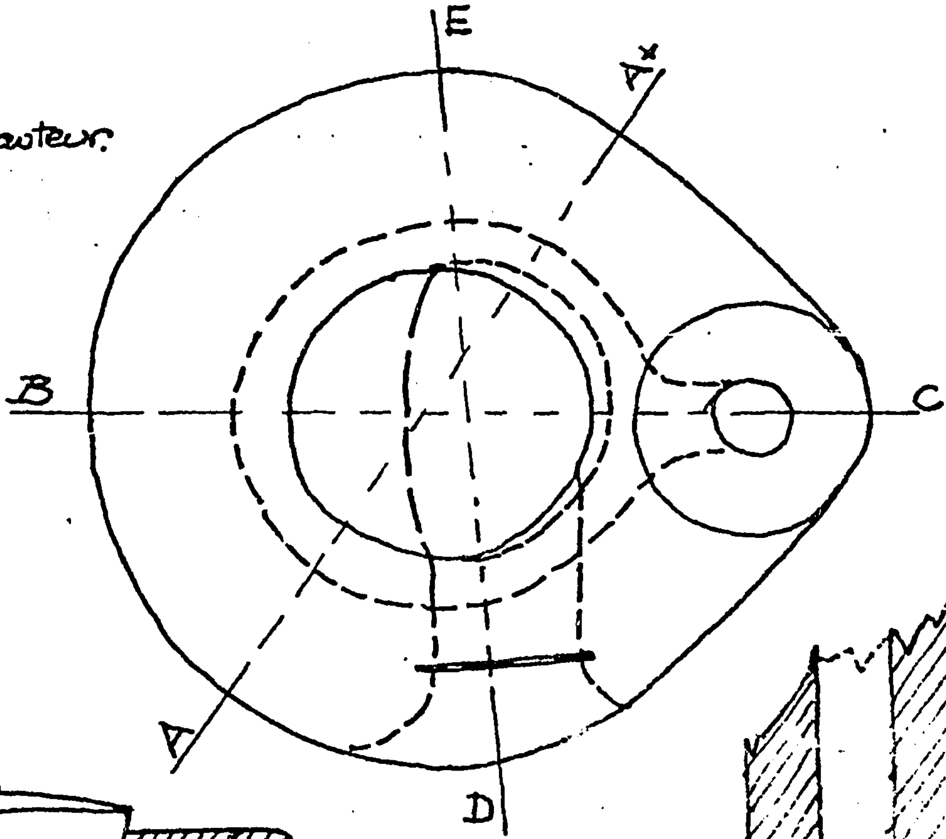


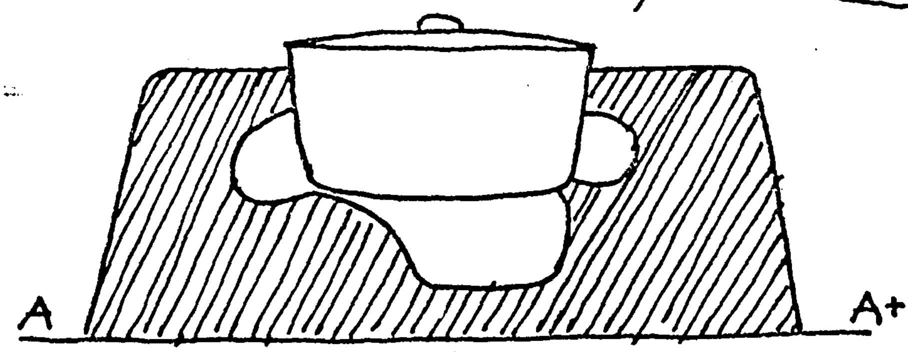
PLAN

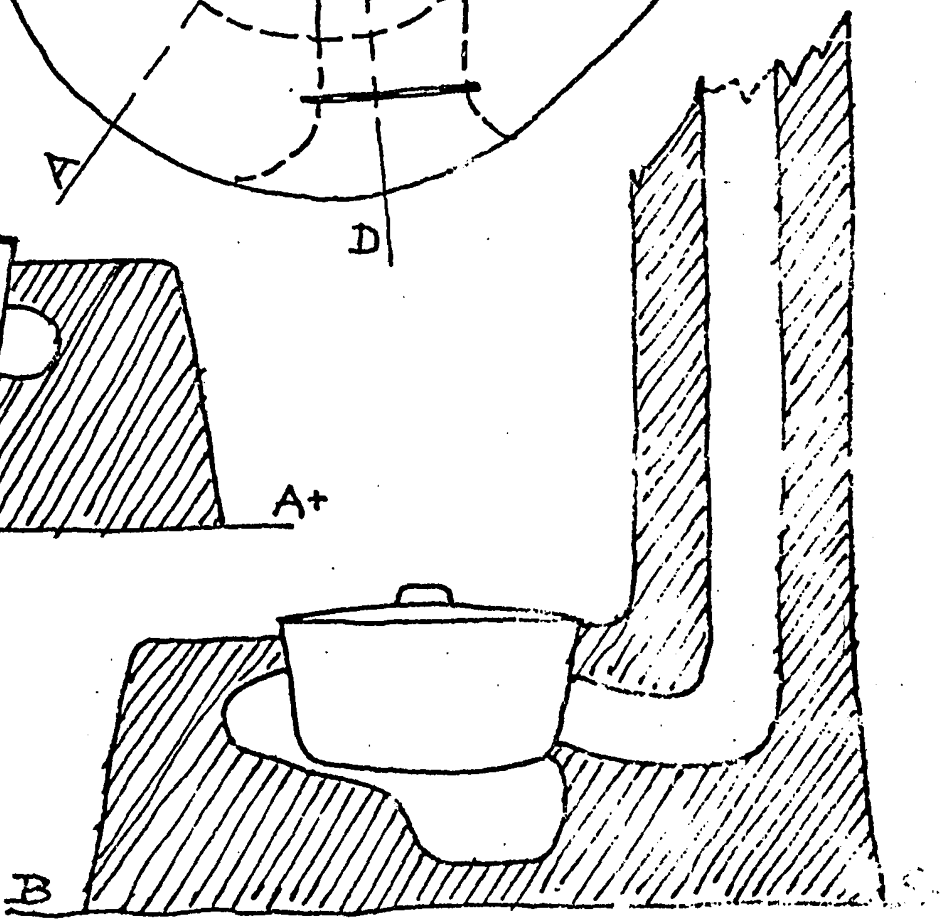
FOURNEAU BANN-AG-SOUF

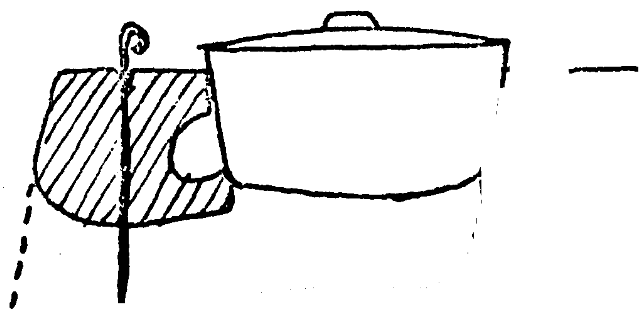
MODELE 1-M8

72cm x 80cm x 28cm de hauteur.

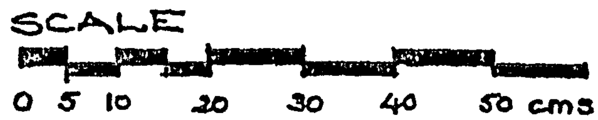




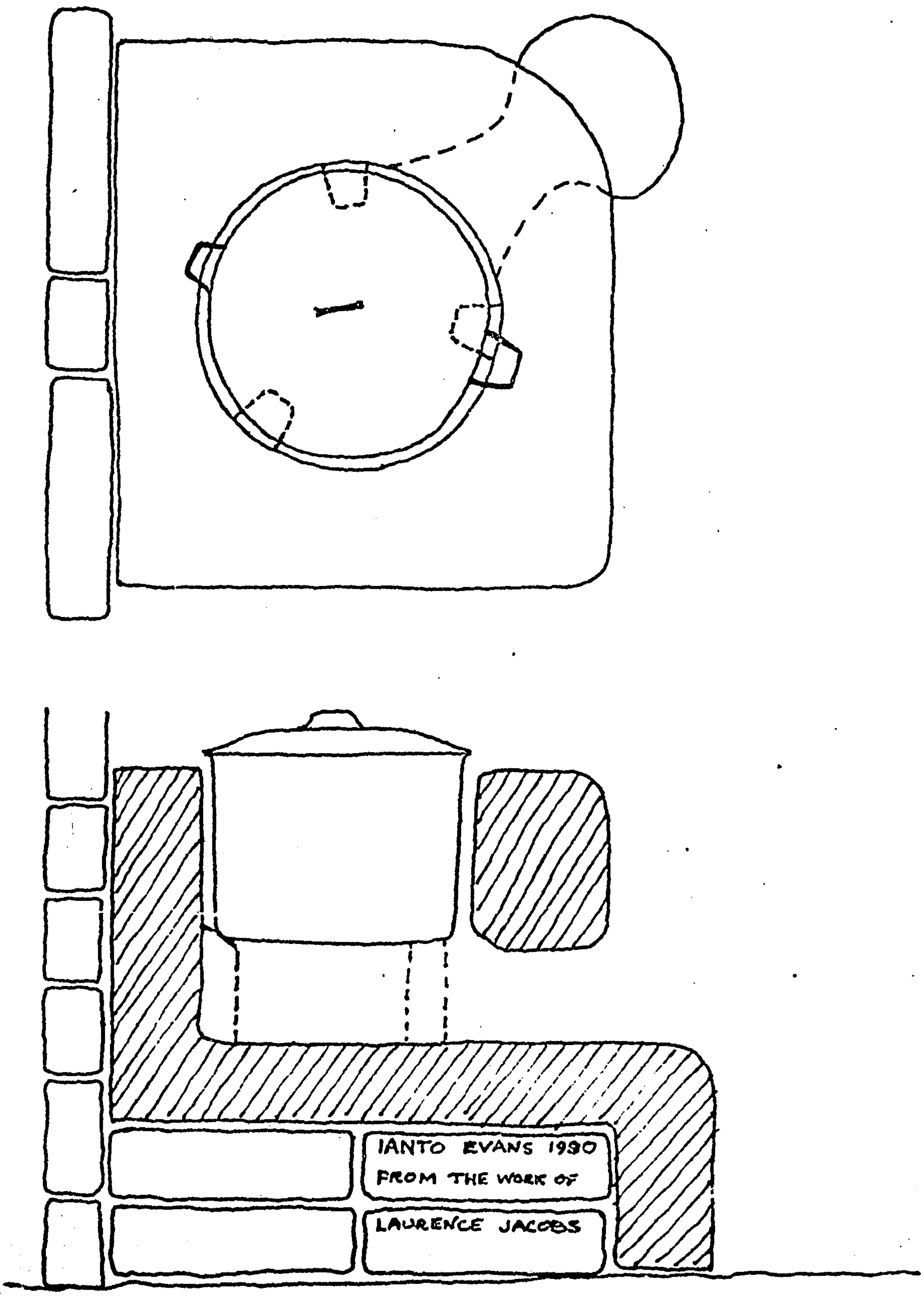




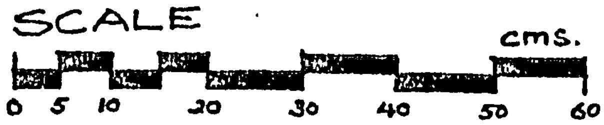
M3 TYPE STOVE #4



VILLAGE: LORO
MIX: 4 SAND TO 1 BLACK CLAY
BUILT: 2 MARCH 1980



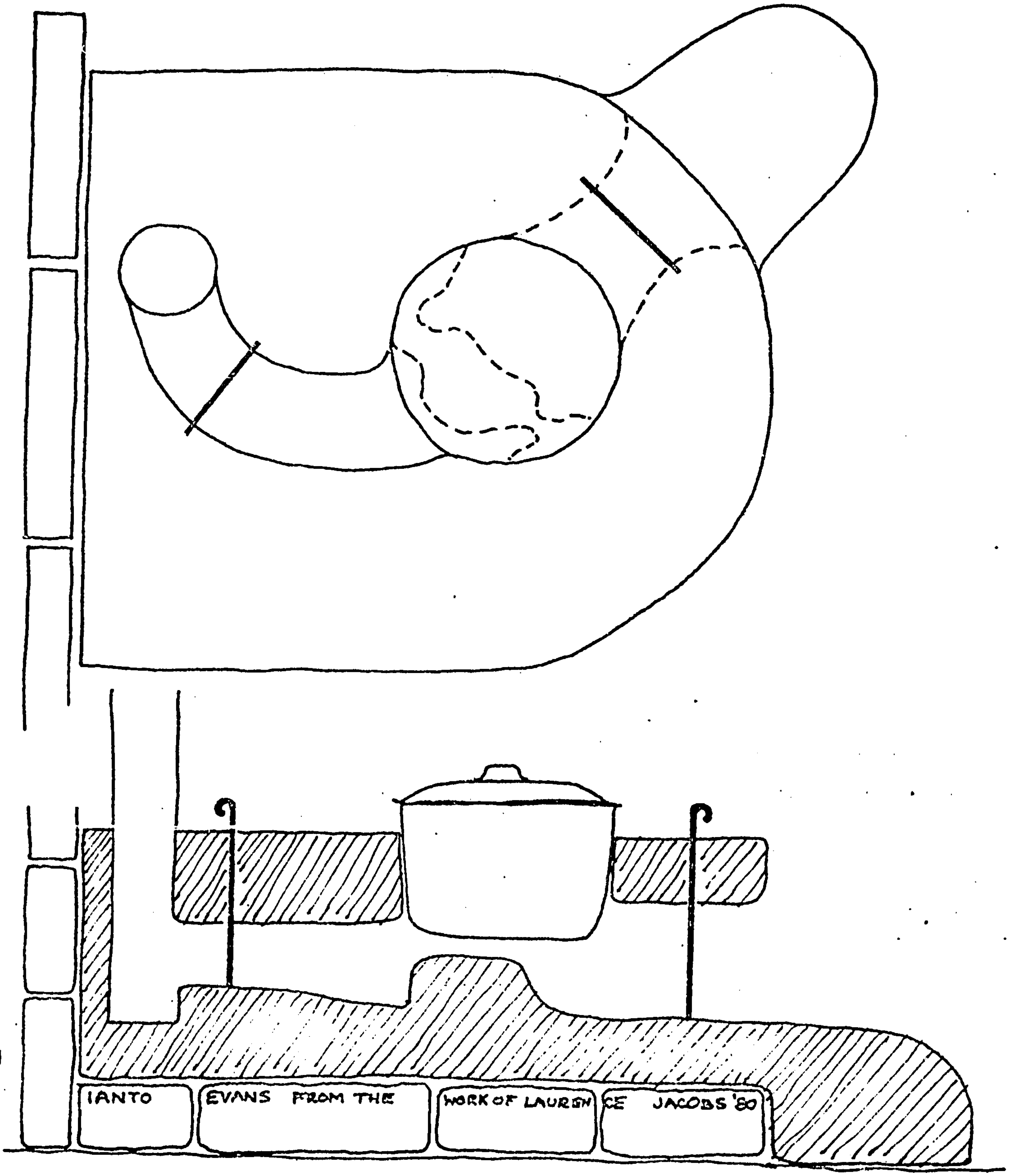
M2 TYPE STOVE #1

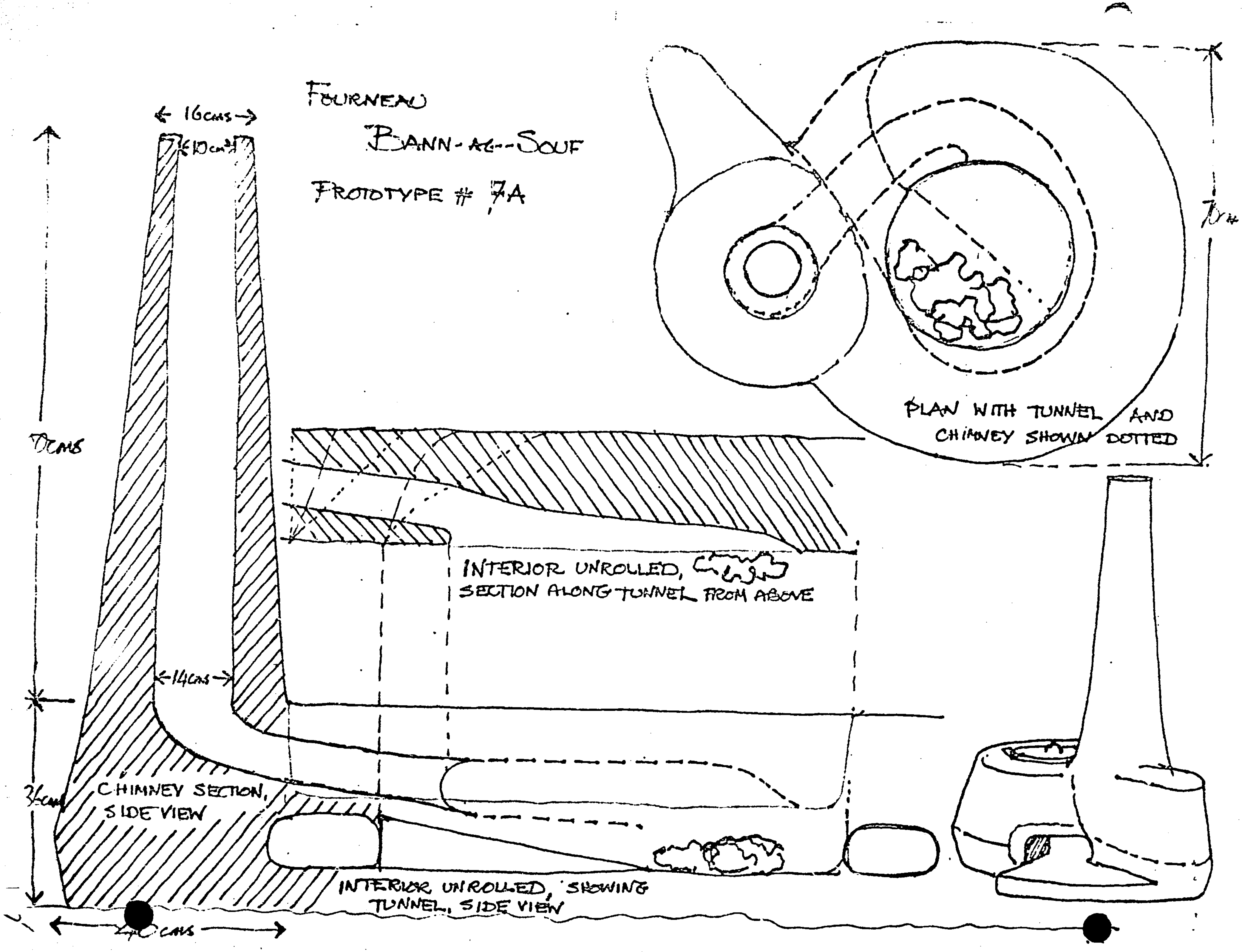


VILLAGE: THIOLAM FALL

MIX: 3 SAND TO 1 CLAY   NO CRACKS. WORKS WELL

BUILT: FEB 21 1980, FIRED FEB 28. USED REGULARLY




FOURNEAU
BANN-AL--SOUF
PROTOTYPE # 7A
16cms
10cms
14cms
CHIMNEY SECTION, SIDE VIEW
INTERIOR UNROLLED, SECTION ALONG TUNNEL FROM ABOVE
INTERIOR UNROLLED, SHOWING TUNNEL, SIDE VIEW
PLAN WITH TUNNEL AND CHIMNEY SHOWN DOTTED