Constraints

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1. Poor People cannot afford to buy peat in large quantities. Essentially cannot afford to buy peat once free supply ran out. Peat is ~~also~~ sold in 30 kg sacks and poor cant buy it. Therefore, they buy charcoal which is slightly more expensive, but they can buy it in small quantities.
2. Rural areas, people don't buy fuel they gather it. A couple of small towns buying wood. Generally use agricultural wastes before buying fuel.

CATHOLIC RELIEF SERVICES

UNITED STATES CATHOLIC CONFERENCE

DESIGN AND FIELD - TESTING OF THE FIRST LOW COST BURUNDI PEAT STOVE

REPORT PREPARED BY

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OCTOBER 1980.

ONATOUR (OFFICE NATIONAL DE LA TOURBE)

BURUNDI

TABLE OF CONTENTS

Chapter		Page
I.	Introduction to the Report.	1
	Problems Prior to the Start of the Stove Project.	2
	Accomplishments.	2
	Problems Remaining for Future Stove Work.	3
	Recommendations for Future Stove Work.	3
II.	Food Preparation.	7
	A. Current Cookstoves.	7
	B. Foods Commonly Prepared.	8
III.	Social Aspects of the Field-Testing of Stoves Prepared by Cynthia Tobias	10
	A. Stoves at Middle Income Level Houses.	10
	B. Stoves at Low Income Level Houses.	12
	C. Lessons Learned from the Field-Testing.	17
IV.	Technical Aspects of the Design and Field-Testing of Stoves. Prepared by Riaz Gondal	19
	A. Introduction	19
	B. First Experimental Stoves	20
	1) Design	20
	2) Construction	22
	3) Accomplishments on First Experimental Stoves.	23
	4) Problems with First Experimental Stoves	23
	C. Modifications Resulting From Field-Testing.	23
	1) Improvements to Increase Fuel Efficiency of Stoves.	23
	a. Tunnels	23
	b. Air Flow	25
	2) Improvements to Decrease the Cost of the Stoves.	26
	a. Removal of Steel Plates.	26
	b. Chimneys	26
	c. Other Metal Parts	27
	3) Other Modifications	27
	a. Chimney Location	27
	b. Plastering	27
	c. Pothole size	27
	d. Indoor Stoves	28
	D. Issues Not Yet Resolved.	28
	ANNEXES	
	Annex 1. Descriptive Brochure and Instructions for Peat Stove.	
	Annex 2. Peat Stove Monitoring Form	
	Annex 3. Cost of Materials	

I

INTRODUCTION,

For several years the AID-sponsored, C.R.S.-administered Projet Tourbe has been devoted to developing peat as an alternative fuel source in Burundi, one of many developing countries suffering from serious deforestation due to heavy use of charcoal and firewood for cooking. Until early 1980, project resources were concentrated on developing labor intensive peat extraction procedures, and the peat produced was marketed primarily to institutional users, such as the army. The last six months of the project called for a sociological survey of the constraints to the household use of peat, and for the development of a suitable stove for household cooking.

Riaz Gondal was hired in May to develop a stove model and had it ready for field-testing in July, at which point the sociologist, Cynthia Tobias, also became directly involved in the stove project. The next two months saw intensive field-testing of the stove design with continual modifications based on the results of the testing. Intensive follow-up, on a daily basis during August, was carried out to determine reactions to the stove and to instruct people in its proper use. The sociologist's assistant/interpreter helped with this work until her return to her teaching position on September 15.

The results of the peat design and testing phase of the project are important not only as the first effort to develop a low cost, fuel efficient peat stove for a developing country, but also because they are the first attempt to introduce any kind of fuel efficient clay stove in Burundi. This review of both social and technical factors involved in the peat stove design and testing work should be of use not only to the current project, but also for those working on other stove projects both in Burundi and elsewhere.

It should be pointed out that this stage of the work was purely experimental and focused only on the proper design of the peat stove, rather than on the large scale popularization of either peat or stoves. In May 1980 it was not even known whether it was possible to build a cheap clay stove for peat.

By August it was clear that it was not only possible, but also that people would use and like the peat and the stoves.

Problems Prior to the Start of the Stove Project.

1. Development of the first low cost, fuel efficient stove which would be technically suitable for cooking with peat. Peat requires constant good air flow for complete combustion. Smoldering peat produces heavy, unpleasant smoke.

2. Introduction of a totally new fuel. Many people had never heard the local word for peat, ibizuku, and could not believe that the peat brick which they were shown would burn.

3. Introduction and testing of a totally new type of stove in low and middle income households of Bujumbura. Only simple metal charcoal grills or three rocks were previously used for cooking. No other clay stoves at all were found in Bujumbura.

Accomplishments.

1. Acceptance of peat was generally good. Used in the stove it provided a hot, longlasting fire, which pleased those who used it.

2. Two common myths about peat, that it smoked too much and that it would eat holes in light metal cooking pots, were proved to be untrue under proper use conditions.

3. The general reaction was that beans, the principal food, cooked very well on peat. Some users even thought they tasted better cooked on peat.

4. The complex air flow requirements for proper combustion of peat were satisfactorily resolved by a system comprising dampers, chimney and grate. Consistently good air flow can be obtained with minimal effort, which allows for proper combustion and almost no smoke.

5. Materials costs for the stoves were greatly reduced by replacing metal parts with clay or bamboo.

6. A system of tunnels was developed which transfers the heat from the firebox to the potholes and limits the loss of heat through the chimney.

7. The stoves attracted much attention in the neighborhoods where they were built and were their own best advertisement. After three stoves were built in the field, there were more requests for stoves than could be filled, even when people were asked to pay for construction materials.

Problems Remaining for Future Stove Work.

1. The successful introduction of the new stoves and fuel will require intensive work by a group of trained local extension workers. At present, there are none.

   Learning to use the stove properly is not difficult, but it involves totally new concepts. Therefore people must be taught and shown how to use it. One lesson has proved to be insufficient. It appears that several visits over the course of one or two months are necessary. The importance of this intensive follow-up cannot be overstressed.

2. People are accustomed to cooking only over a hot direct fire. They do not know how to cook with the lower temperatures provided in the second and third potholes. This will also require intervention by trained female extension workers who can demonstrate cooking techniques in homes and public places.

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3. There is currently no peat marketing network, so householders who wish to buy more peat must purchase it in large quantities at ONATOUR and transport it to their homes. This has proved to be particularly difficult for low income people who cannot purchase large amounts of fuel at one time. At present, the project delivers peat to those willing to buy it by the sack (about 40 kilos). Clients may be lost after termination of the project, if peat cannot be delivered.

4. The first stoves were built outside during the dry season for householders who promised to build roofs over them. Several of them have failed to build the roofs and some stoves are showing rain damage. This indicates a lack of concern on the part of the houseowners, usually men, who are not involved in cooking on the stove, who have to provide the money to build the roof. The housewives and cooks are generally enthusiastic about using and protecting the stoves, but are unable to pay for the roofs themselves. Extension efforts should perhaps be aimed at husbands as well as wives.

5. Local people are not currently involved in stove construction, except for one laborer who assists the stove designer. He had not yet learned to construct tunnels properly at the close of the project.

6. The quality of clay available in Bujumbura is not good, and the present source of clay is nearly exhausted. Purchased clay is very expensive, so a new source of clay must be located. If it is not available in Bujumbura, a means of transport must be arranged.

7. The supplier of the metal parts of the stove has found it necessary to increase his prices, which will substantially increase the price of the stove.

8. The stoves work well with very dry peat, which is not always supplied. Damp peat is difficult to light and smokes excessively, thus providing bad publicity.

Recommendations for Future Stove Work.

1. Training.

   A. Extension Workers : A group of local women should be trained to do extension work, including stove demonstrations, local publicity work, and follow-up work on new stoves and peat. Some of the male artisans should also participate in demonstrations.

   B. Local artisans : A group of local men should be trained in all phases of stove construction.

2. Materials.

   A. New sources must be located for clay and metal parts if work is to continue. Possible sources have been identified.

   B. Alternative materials such as fired clay, bamboo and light metal should be tested to reduce costs.

   C. The Ecole d'Art at Gitega may be able to supply fired clay parts, and might also be able to give advice on clays. Further contact with this institution is recommended.

3. Workshop and Tools.

   A. There are three alternative solutions to the workshop problem :

      (1) To establish a central workshop which would produce and store materials to supply to stove constructors. It could also be used to train local artisans.

      (2) To rent a portion of an already established workshop in which to work and to train local artisans.

(3) To constract out the work to already established local workshops, if satisfactory arrangements can be made on quality and price.

B. Tools.

At present the project owns two trowels, a measure and a level. Masonry tools and simple metalworking tools will be necessary for continuation of the stove work.

4. Testing Other Stove Models.

A. A prototype imbabura for peat has been developed. It requires field testing and further modification.

B. Further experiments with small, low cost clay stoves must be carried out.

C. Other design modifications discussed in this report should also be tested.

5. Publicity.

A. Once a core group of extension workers and artisans has been trained, a publicity compaign should be inaugerated to publicize peat and peat stoves. This might include : the construction of model stoves in locations where many people pass through, and special stove demonstration programs, including both construction and use aspects, given at night at various suitable locations in the neighborhoods, and incorporating lectures, films and lightweight models of stoves. Such programs could also be presented in schools.

B. Stoves could be constructed in the houses of influential people willing to test and help publicize them.

6. Interim Between Phases.

The development and field-testing of the peat stove has been successful and has provided good publicity for both peat and the stoves. Interest in the neighborhoods is currently high, and any substantial time lag between phases risks losing the advantage already obtained. Both the stove work and the extension work should begin again as soon as possible in Phase II.

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II

FOOD PREPARATION.

A. Current Cookstoves

There were two main types of cookstoves used in the 121 households surveyed in Buyenzi, Nyakabiga, Ngagara and Kinama. One was the local metal charcoal grill, called the imbabura. This is a very simple round metal basket with holes cut in the sides. The sides come up only a few inches, so much heat is lost into the air as well as by conduction, through the metal. The average imbabura costs about 125 Bu. Fr. or about U.S. $ 1.40 and lasts for 5 to 6 months. Other more expensive models are also available, but are not generally used by low and middle income people. (See Figure 1) A simple test compared 20 Bu. Fr. of peat with 20 Bu. Fr. of charcoal in the most common model of imbabura. The charcoal burned for 2 hours, the peat for 4.

The only type of "stove" currently available for those who cook with wood is three rocks. This is very fuel inefficent, as heat is lost both from the sides and from the top. The great majority of Burundi's population is rural and uses only the three rock method, with firewood, agricultural residues or dung. A few houses in the sample survey used a small kerosene stove, rechaud, as a backup to charcoal.

The sample of 0.4% of the households of Bujumbura revealed no clay stoves of any type currently in use. The task faced by the project was therefore doubly difficult since not only was it necessary to introduce a new fuel, but also an entirely new mode of cooking, the clay/brick stove.

B. Foods Commonly Prepared.

The basic food items consumed in the households surveyed in Buyenzi, Nyakabiga, Ngagara and Kinama zones of Bujumbura were beans and manioc. About 67% of the respondents reported that they had prepared beans the previous day. The customary way of preparing beans is to cook them at a continual fast boil throughout the cooking period of about 2 to 3 hours. Methods of slow-cooking beans or other foods appear to be unknown, perhaps because only the direct fire cooking method is used by most people. The multiple pot hole stove would allow a very efficient use of fuel if people can be taught how to cook on less heat. There have been some objections due to the time involved, up to 5 hours for beans on the second pothole, which indicates that cooking fuel is still not expensive enough to cause people to value it more highly than their time.

Other commonly prepared foods are varieties of yams, bananas, fish, meat, rice and potatoes. Both yams and bananas can be placed directly on the grate with the fire to cook. At least one household customarily cooks rice or potatoes on the second pothole of their stove with good results. This household always covers the pots tightly which decreases cooking time. Small fish, ndagala, have been boiled successfully on the first pothole. Meat could be advantageously slow cooked on the second or third potholes. However, most households rarely eat meat and no one reported trying this method of preparing it. Breakfast is a very light meal and usually the only warm food consumed is tea or bouilli.

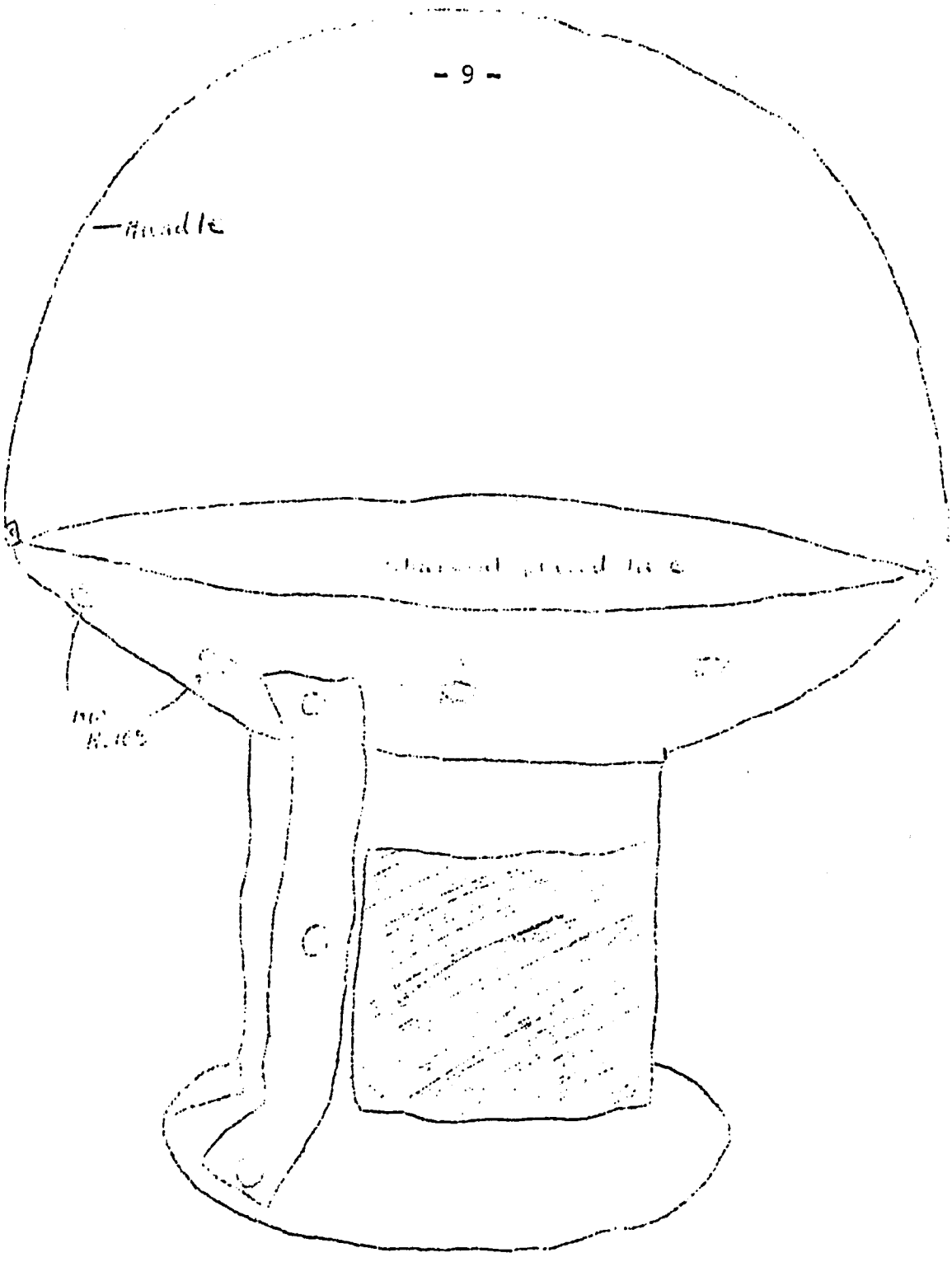

FIGURE 1
CHARCOAL GRILL (INCORRECT) FOUND MOST FREQUENTLY IN LOW AND MIDDLE INCOME HOUSEHOLDS

III

Social Analysis of Field-Testing of the Stoves.

Prepared by Cynthia Tobias

Between July and September five stoves were built in the field for testing both the adequacy of stove design and the acceptability of peat. The stoves monitored were located in Buyenzi, Ngagara, and Nyakabiga zones of Bujumbura. The first stove was built at the house of a project secretary. The next two were built in the homes of respondents from the household survey who, when asked, indicated that they would like to have a stove and that they would use it and supply feedback on the results. One of these stoves was built in a low income shared compound, the other at the house of a relatively prosperous trader. The latter individual paid 3,000 Bu. Fr. for the materials. All of the remaining stoves were constructed for households which approached us and requested a stove. When metal chimneys were used, the houseowners paid 3,000 - 3,500 francs. Each new stove household was given 2 free sacks of peat. For subsequent purchses of peat, the project provided free delivery, since there were as yet no peat sellers in the zones. All peat is currently sold by the sack at ONATOUR.

A. Stoves at Middle Income Level Houses.

The first stove was constructed at the home of a Project Tourbe secretary. Her household used the firebox pothole almost every day, but they were unwilling to use the second pothole because it took longer to cook. Consequently, they still used charcoal and imbaburas along with the peat stove. This seems to indicate that time was more valuable than money for this household.

A stove was constructed for a family which has a boutique in Buyenzi. Their house had electricity, which classed it among the highest income group in the sample. The houseowner expressed great interest in having the stove installed. It was built in mid-July in a small, open internal courtyard. A teenage daughter and one or two houseboys did the cooking.

The husband and wife were occupied all day with the boutique and other business. When this stove was built, it was the first with an all clay top. Each pothole was made to fit only one pot size. Despite careful questioning about which pots were used every day, the cooks complained afterwards that the holes were made for big pots that they used only on holidays. (1) The potholes were modified, although the new clay could not have the structural strength of potholes dug into the clay mass, and cracked frequently. The houseboy was taught to repair the creacks. This stove was used every day, and a new supply of peat was bought after 10 days. The sociologist and her assistant visited this household daily for several weeks. The stove seemed quite successful until the rainy season began. Despite repeated assurances by the houseowner that the roof would be constructed before the rains began early in September, by late September the stove was not covered and was being damaged by water. Also the peat was allowed to remain outside uncovered and thus could not be used without a long period of redrying. Not unexpectedly the stove was no longer used. The main difficulty at this household seems to be the lack of interest in the stove on the part of the husband and wife, who control the pursestrings. Despite their 3,000 franc investment in stove materials, they did not really want to have to bother with protecting or maintaining the stove. It is still possible, however, that they will build the roof and begin to use the stove again.

The following stove was constructed in Nyakabiga, for a man who requested it. This stove continues to be successful two months after its installation. By request of the husband and wife a large stove with five potholes was built. They brought out a set of new, expensive colored cooking pots which they claimed to use every day. Two days after they began using the stove, they permanently closed three of the holes and began to use their two everyday pots.

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(1) This problem occurred repeatedly despite serious efforts to determine which pots were used most. It appears that people wanted to show only the biggest and best pots to the people who were building the stoves.

After a time, the stovemaker rebuilt the tunnels in the stove to prevent heat from being wasted on the three unused potholes. This experience made it clear that it was better to observe which pots people used to cook with everyday, rather than to ask them. This household consistently uses both potholes and rarely lights a charcoal fire when they have peat. The husband continues to be very interested in the stove and in the money he saves by using peat instead of charcoal. He has built a roof over the stove and also takes care of minor repairs. A problem may occur when the project ends since there is no place for him to buy peat in Nyakabiga and he has only a bicycle for transport.

B. Stoves at Low Income Level Houses.

Two stoves were constructed at the houses of low income people in Buyenzi. The first was a two pothole stove with a metal plate and lids, built in a courtyard shared by three households. The second was also a two pothole stove, but had no metal plate.

The shared stove was unsuccessful and it proved very difficult to get adequate feedback on the nature of the problem. The compound was owned by a very old couple, who rented two small houses within it to two women. From the beginning, the old couple tried to keep the stove for their use only. Since they were keeping the Ramadan fast, the stove was not in use most of the day. Project people visited the compound, and made it clear that the stove was to be shared, and that it must be used daily. For several days, the stove was used and shared, but then use declined. The old couple insisted that the removable metal parts of the stove be kept inside their house. It seems likely that the renters were unwilling to create problems by asking for them whenever they wanted to cook.

There was also a problem at this compound because the people were accustomed to buying cooking fuel in 10 or 20 fr. lots when they needed it and had the money.

They were unable or unwilling to buy peat by the sack even though in the long run it would have been cheaper. A small quantity of peat, i.e. five sods, with a selling price of 24 francs, was taken to the compound and offered for sale. The old woman purchased it. However, she never appeared to use either the stove or the peat, and in fact still had almost one third of a sack of peat in her house when she bought the five sods. A small quantity of charcoal and wood were taken to the compound, and one of the other women was taught how to use them in the stove. She appeared quite happy with the results, but never used the stove again. The old man began to build a shelter around the stove, but after several weeks of work, during which time no one was permitted to cook on the stove, he became ill and after recovering, abandoned the project.

Several local people talked with the old couple in an attempt to determine why the stove was not being used, particularly since they still had a large amount of peat in their house. Various excuses were given. The most common one was that they had no money for food. However, they were observed to be cooking food on an imbabura. The uncompleted shelter for the stove was also mentioned as a reason not to use it. Despite repeated attempts at questioning them, it was never possible to adequately determine why the stove was not used. Possible reasons include the inability to share the stove, the advanced age of the couple owning the compound, or perhaps a simple reluctance to use up the free peat. If there was a problem with the stove's design, it was impossible to find out what it was.

Another low-income household stove was more successful. It was built at the home of the laborer who assisted in the stove construction work. This stove was built to cook sitting down and had a bamboo chimney. A fire was built in the stove every day and it was used to cook beans, manioc, small fish (ndagala) and to heat water. After one week, the peat sods became damp from rain and no longer burned well.

This is a common problem, as people do not realize yet how long peat takes to dry out properly. It was also found that this household was not cleaning the grate. Several inches of ash had completely closed the opening when the stove was checked. The wet peat and the blocked air flow led to inadequate combustion and insufficient heat. The people noticed there was something wrong but did not know what it was, despite having been cautioned about both problems ahead of time. This indicates that intensive and frequent follow-up is crucial. After the problem of wet peat was resolved, the household again began to use the stove regularly.

Peat stove monitoring from

A questionnaire (see annex 2) was developed to assess response to the stove. It was administered approximately one week after the stove was ready for use. It did not appear, however, that the questionnaire was the must effective way to monitor the reaction to the peat stoves, since people seemed to find it difficult to respond honestly to the questions. Observation on frequent unscheduled visits and informal conversations provided more useful information.

Results of the questionnaire follow.

Table I. Was the stove used every day :

	N = 7*
Yes	57%
No	43%

Table 2. Foods prepared on the stove.

	N= 7
Beans	100%
Rice	29%
Manioc	57%
Fish	29%
Bananas	71%
Other	29%

* Note that three women in three separate households were questioned at the low income compound in Buyenzi. Results are provided for 5 different stoves, including the project secretary's.

Table 3. Used stove to boil water

N= 7

Yes, worked well	86%
Didn't try	14%
	100%

Table 4. Took longer to light peat than wood or charcoal

N = 7

Yes	43%
No	57%
	100%

Table 5. Other materials used to help start the fire

N= 7

Paper	71%
Wood	71%
Lighted Charcoal	29%

Table 6. Number of times per day the fire is lit

N= 7

Once	57%
Twice	29%
Three Times	14%
	100%

Table 7. Does it take longer to cook with peat than charcoal

N= 6*

Peat takes longer	17%
Charcoal takes longer	17%
Same time for both fuels	67%
	101 % due to rounding

* One household did not use charcoal.

Table 8. Have to add peat more often than charcoal

N= 6*

Yes	50%
No	50%
	100%

Table 9. Also used charcoal or wood to cook this week.

N= 7

Yes	57%
No	43%
	100%

Table 10. Want to buy peat when free supply is gone

N= 7

Yes	100%
No	0%
	100%

Table 11. Like cooking standing up

N= 6

Yes	100%
No	0%
	100%

The results of the questionnaire are rather inconclusive. Observation and informal questioning revealed that people were generally happy with the fire produced by the peat. The fire in the first pothole remained very hot for a long period of time. The only household which regularly used the second pothole for cooking was in Nyakabiga. Although food took longer to boil there, they were willing to wait in exchange for the money saved by making only one fire, under the first pot. Once people knew how to light the fire properly, it did not usually take them any longer to get the peat fire going. Paper, small pieces of wood and burning charcoal were used to start the fires. As long as the peat was dry, it was easy to light in the stoves because they provided good draught. In several cases, the questionnaire helped to identify problems in the use of the peat which could be corrected.

* One household did not use charcoal.

Athough the questionnaire was originally intended to be administered several times, it was decided that given the small number of cases it was better to use a more informal system of data collection. It was possible to provide considerable guidance in proper stove use and also to make actual design modifications during the course of the testing. Perhaps most noteworthy is the observation that one or two training sessions were inadequate in most cases. It took repeated visits and demonstrations to teach people how to make and tend the fire properly. This is perhaps not surprising given that both the fuel and the stove were totally new items. Also worthy of note is the fact that the three women from the low income compound in Buyenzi all gave very positive responses when the questions were asked, yet they stopped using the stove very soon after.

C. Lessons Learned From the Field-Testing

1. To get adequate feedback on the design and construction of the stove, it was essential to select households which were seriously interested in using and testing the stove, and where the respondents were able to understand the object of the experiment and respond honestly to the non-Barundi who came to question them. This indicates that a slightly higher income, better educated group is preferable for field-testing. The exception was the laborer's family where both he and his brother were interested in the stove and involved in its construction.

2. A maximum of three potholes will be used and two may be sufficient in most cases. Few people wanted to keep water heating for washing on the third pothole.

3. Most people liked cooking standing up, even those who had said before that they preferred to cook sitting on the ground.

4. In this early stage of peat stove development, observation and informal conversations provided more useful and valid feedback than a formal questionnaire.

5. Response to both peat and to the stoves was generally positive. Beans, the principal food in most houshoolds, cooked very well and many people thought they tasted better.

6. If male members of the household were interested in the stove, it was more likely to be properly maintained. This indicates that an extension effort must not be focused solely on women.

IV

TECHNICAL ASPECTS OF THE DESIGN AND FIELD-TESTING

Prepared by Riaz Gondal

A. Introduction

" The formation of peat is the first stage in the process of the decomposition of vegetable remains which leads, through the geological ages, to the formation of coal. This process cannot take place except in the presence of water because, when exposed to the air, the components of plants (Cellulose, lignin, resins and waxes) are very quickly mineralized by the action of oxygen. Under water an anerobic rotting process leads to the formation of products rich in carbon, which form a layer of mud at the bottom of bog ; while at the surface of the bog the plant life continues to feed the system. The growth of a layer of peat is relatively slow. In 1,000 years an active peat bog produces a layer of peat about 0.33 m deep. Still, that is rapid when compared with the formation of a deposit of lignite, which requires 100,000 years to form a layer one meter deep " 1

Peat is in abundant supply in Burundi and can be utilized for domestic cooking. Peat responds quickly to changes in draught. It has similar combustion characteristics to wood and coal. Peat is highly reactive, i.e. it burns easily and completely under proper conditions. Its ignition temperature is the lowest of all solid fuels. Well dried peat will begin burning almost immediately.2 Burundi peat has a high ash content (15 - 40%, 25% average), a low density (0.3 - 0.7), friability and a tendency to contain undecomposed vegetable matter. Ruston (1974) estimates that the average calorific value is 3130 Kcal/Kg. Current estimates of Burundi's peat reserves are just over onemillion tons at six promising bog sites and an estimated 100 - 200 million tons under water in the Gran Marais. (3)

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1. Utilisation Industrielle de la Tourbe Burundi, Ruston Technical Services International, Brussels : 1974

   Translated into English in Dr. John J. Gaudet, Ecological Report on Peat Harvesting in Burundi ; CRS, June 1980 P.9

2. Use of Turf in Industrial Appliances , Bord na Mona, undated, P. 14

3. J. Walton, Peat Exploitation in Burundi, June 1980

Smokeless fuels such as coke contain practically no combusible material except for carbons. However, peat, wood, etc. contain various amounts of hydrogen. The hydrogen creates "volatiles" or smoke during combustion. The volatile content affects the tech technique required for proper burning. If a peat fire is not properly prepared, the volatiles will not be consumed and excessive smoke will be produced during combustion. Several chemical elements are released during the combustion of any fuel. Sulphur is one of the most troublesome elements in view of deposit formation and metal corrosion. However, the sulphur content of peat is low, and if fuel gases are kept over the dewpoint, and proper combustion techniques are used, there should be no problem. Peat requires primary and secondary air sources. The primary air coming from under the grate and passing through the fire burns the fixed carbons. Secondary air entering through the firebox entrance flows over the top of the fuel and makes the volatiles burn (4).
The current project experimented with several stove designs in an effort to develop a technically and cost efficient stove model.

B. First Experimental Stoves.

The first stoves were constructed at the metal workshop of Mr. Din, RIAZJLAH INDUSTRIES, located in the Quartier Asiatique. The metal parts for the stoves were supplied by the work-shop but clay and bricks were brought from outside.

The goals for the first experimental stoves were set by Mr. Joshua Walton the former Project Manager and included :

The stoves

I. Must be easy to build.
II. Must be cheap, therefore, few metal parts.
III. No smoke must escape except through the chimney.
IV. Must be reasonally clean.
V. Must have metal chimney.

The design and construction of the first stoves attempted to meet all of these goals.

1. Design

The first stove design was made with the basic shape of the Indian type " Magan choola", see Figure.

(4) Use of Turf.... P. 5 - 7, 17

To ensure that the stove would be airtight and strong enough to support the pots, a steel metal plate was put on top of the stove. Holes were cut in the plate to sit the pot on and metal lids were made to cover the holes when they were not being used for cooking, to prevent heat and smoke from escaping, since peat stoves have particular air flow requirements, i.e. they must have primary and secondary air sources. The air chamber was constructed with an entrance from the side below the firebox as the main source of primary air. The air chamber also functions as an ash collection place for the firebox. The grate was put at the botton of the firebox for ashes to fall through and to allow air flow through the fire.

The damper was placed on the firebox opening to control the main source of secondary air. This and another damper were placed just before the chimney to control the air flow through tunnels toward the chimney. Curved tunnels 20 cm. deep were made inside the upper level, the firebox level, to transfer the heat from the firebox to all the pot holes. A 2m. metal chimney having a 14 cm. horizontal cap open on both ends was placed at the back of the stove for better draught and to allow some smoke to come out and diffuse into the air. The inner diameter of the chimney was 9 cm. The cooking surface was approximatly 70 cm. high to permit cooking standing up. Three cooking places were provided. The first pot hole was immediately over the firebox, the second was 10 cm. away from the firebox and the third was 10 cm beyond.

The second experimental stove incorporated various modifications in the design. It was decided that the original stove was too large to fit into small kitchens. The second stove had only two cooking places since only one or two foods are generally prepared. The second pothole was directly behind the first in a rectangular stove. There was approximately 12 cm. distance between the two potholes and the first one was larger than the seconde one. The distance between the two potholes was 10 cm. and between the second pothole and the chimney it was 6 cm. The firebox and grate in the second stove were made larger and wider than in the first stove.

The air control system was improved following the instructions of Mr. Martin, USAID Technical Adviser, by placing a sliding damper on the air chamber.

..../22

The entrance to the firebox and air chamber were both in the front of the stove. A metal ash carrier was provided to make removing ashes easier. Raised metal collars of about 2 1/2 cm. were made on the edge of the metal plate at each pothole and the edges of the lids rested tightly on these. The collars were to prevent the smoke from escaping. For better draft the chimney was placed on top of the stove fitted into a metal collar like that used for the potholes.

2. Construction

Materials used in the first stoves included clay, sand, bricks, metal plates, lids, grates and dampers. The most difficult material to locate was clay. In Bujumbura it was difficult to low cost good quality clay. Eventually a source of free reasonalily good clay was found near Lake Tanganyika. It was a mixture of sand, clay, pieces of stones etc...

A base having a brick frame of 90x80x40 cm, was built and was filled with a mix of pounded brickbats, clay/sand mix and broken pieces of stone. This comprised the platform on wh the stove was built. The stove walls were built of bricks and the air chamber, firebox and tunnel walls were made out of brickbats and stones. All inside and outside walls and the stove top were p plastered with the clay/sand mixture which was dampened everyday for ten days to produce bacteria and smoothness of the clay. The edges were made smooth with a board . Sliding metal dampers for the firebox and chimney were made out of 2 mm Ø metal sheets and frames for the dampers were made from metal strips.

A 2 mm Ø metal sheet was welded to make a 10 cm Ø chimney. The second experimental stove had a base of 90 x 45 x 40 cm, built in the same way. The stove walls were constructed leaving a 10 cm. ledge at the edge of the platform. A special white type of pure clay from upcountry was tried mixed with sand for plastering the stove top and the sides. The clay cracked badly. The stove was replastered with a mixture of rice hulls and clay and sand leaving it for 14 days with daily dampening. The sliding dampers and chimney were constructed in the same way.

3. Accomplishments on first experimental stoves.

a) A satisfactory design was achieved which prevented smoke from escaping except through the chimney.

b) The stove was simple in design and relatively easy to build.

c) Heat was conserved inside the stove due to its clay and brick construction.

d) A system of air flow control was developed which permitted good combustion of the peat and limited smoke.
The system included dampers for primary and secondary air, air tight lids and a 2 meter chimney.

e) Good heat could be achieved in all potholes.

4. Problems with the first experimental stoves.

a) No equipment was available for testing accurately the amount of heat produced, or for comparison with other stove models.

b) The chimney was too hot indicating that heat was being wasted.

c) There were several metal parts which accounted for about 2/3 the cost of the stove.

d) The pure white clay used to plaster the second stove cracked badly.

c) Pots did not fit down into the potholes where they could better use the heat, but instead rested on top of the holes.

C. Modifications Resulting from Field Testing.

Actual field testing of the stoves led to various modifications to the basic design. A principal goal was to make them use the fuel more efficiently. Another continuing goal was to reduce the cost of the stoves to make them more accessible for low income people. An attempt was also made to improve materials.

1) Improvements to increase the fuel efficiency of the stoves.

a) Tunnels

A system of tunnels was developed to transfer heat from one pothole to another. In the first stove, deep narrow tunnels were built. In the second, the firebox was very large so that a fire could be built under both potholes.

Two additional stoves were built in the field using basically the same model as the second stove. This stove proved to use an excessive amount of peat. The two field stoves were modified to reduce the size of the firebox by half, and a tunnel about 10 cm. deep and 6 cm. wide transmitted the heat to the second pothole. A mound of the clay/sand mixture was placed at the bottom of the second pothole to force the hot air to circulate around the bottom of the pot, as in the Lorena model.
About a 7 cm. gap was left between the mound and the bottom of the pot rather than the 5 cm. of the Lorena model, which impeded the airflow through the peat stove.
Although this design used less peat, the stove was too small to permit construction of a proper curved tunnel system and heat was still being wasted, as evidenced by the hot chimney. The next stove was a larger stove about 100 x 110 cm. It included 3 potholes connected by curved tunnels following the Lorena model.

The chimney was cool which represented a major advance as the heat was conserved within the stove for cooking. However, heat was not adequate for cooking in the second and third potholes, perhaps because of the lower calorific value of peat.
The distance between the firebox pothole and the remaining potholes was decreased in later stoves, and tunnels were less curved.
This provided better heat for the second and third potholes. The most recently constructed stoves have the second and third potholes connected directly to the firebox via separate tunnels.
This allows the flames to reach both of them and provides good heat for both. At present, it seems to be the best solution for 3 pothole stoves. At first the tunnels were dug open from the top. After they were completed, metal bars were put in as reinforcement and the roof of the tunnel was covered with bricks or clay. Later, tunnels were dug from within with knives or whatever other tools were available. This allows a better slope and shape for the tunnels, and also eliminates the metal bars, which increased the cost of the stove.

2. The firebox size was changed often in an attempt to determine the smallest size possible consistent with good heat for the entire stove. The average size of the peat sods, 19 x 6 cm, makes it necessary to have a deeper firebox then would be required for wood. 28 to 30 cms. appears to be the best depth for the peat firebox. A firebox 25 cm. wide by 30 cm. long is best for a 3 pothole stove. This will allow up to 4 peat sods at a time.

b) Air Flow

Various experiments were tried to improve the draught in the stove. The location and size of the air chamber was changed. The damper system was modified, as were the grates.
The air chamber was variously located on the front of the stove or at the side. In areas without wind, the airflow seemed to work equally well with the chamber entrance on the side or on the front.

However, a stove with an airchamber on the side located on a windy hillside developed draught problems when the wind was strong. It therefore appears that if wind will be a problem, the air chamber and firebox entrances should both be on the same side of the stove.

Various damper systems were also tried. Most of the time, the firebox damper remains closed. It is usually opened to add peat and when the fire is being lit. On one stove the firebox damper was removed. Since it was in an open location, with good air circulation, the stove worked fairly well. However, experience has shown that better air control and draught can be achieved with two separate air sources, and all other stoves were built with both firebox and air chamber dampers. It is also easier to add peat through the firebox door, rather than through the pothole, when a pot is in place and hot.

A chimney damper was placed in all of the later stoves and proved useful for controlling the flow of heat and unburned gases (smoke). When the fire was burning well and there was little smoke, the chimney damper could be almost entirely closed to retain heat for cooking.

Adaptations were made in the grate under the fire to obtain a more efficient air supply. Originally, the distance between the bars of the grate was 2 cm ; it was later reduced to 1 cm. One centimeter proved to be insufficient as the ashes were not falling through the grate easily and the stove users were not cleaning the grate properly. The best distance appeared to be 1 1/2 cm. apart. The first bars were 4 mm Ø. They were increased to 6 mm Ø to provide a longer lasting grate..
The size of the grate was also adjusted. In one stove, the grate was 14 cm wide in a firebox with a width of 25 cm.

Again this was inadequate because the stove users were not cleaning the grate when necessary. Later models were constructed with the grate nearly as long as the firebox. Early models have fixed grates. On the suggestion of Mr. Ian Pattinson, the project manager, later models were built with removeable grates, since it was presumed that they would eventually be damaged by repeated fires.

2) Improvements to Decrease the Cost of the Stoves.

a) Removal of steel plates.

The steel plates and lids on top of the stove added nearly 1000 francs to the cost of the stove. An experiment was carric out to determine whether the entire top of the stove could be made of the clay/sand mixture. This experiment was successful and all further stoves were made without the metal plate.

The bottom of the stove is filled with dry clay, sand, brickbats and stones left after sifting, to a depth of 35 cm. Then a wet clay/sand/ricehulls mixture (10 parts clay/sand to 1 part rice hulls) is placed into the stove frame up to the top. After it dries, [illegible] and pot[illegible] are cut into the clay/sand mass. Pothole sizes are determined first by placing frequently used cooking pots on the smooth leveled top of the stove. Each pothole was designed to fit several different pots.

b) Chimneys.

The metal chimney also added over 1000 francs to the cost of the stove. The cheapest alternative is a bamboo chimney, commonly used in some other countries. However, although there are reported to be large diameter bamboos upcountry in Burundi, only one could be found in Bujumbura. It is being used successfully.

A 30 to 50 franc bamboo chimney is clearly the cheapest alternative, and further attemps should be made to find large bamboos having an inner diameter of 10 to 12 cms.

Another alternative is a fired clay chimney. Thus far such a chimney has not been available for testing, as there are few potters and they cannot do complex jobs.

One such chimney has been requested from the Ecole d'Art at Gitega and will be tested as soon as it arrives.

C) Other Metal Parts.

At present, no satisfactory alternative to the metal dampers exists. Fired clay lids were ordered from some potters which were not successful. New ones have been ordered from the Ecole d'Art at Gitega but are not available for testing at this stage.

3. Other Modifications

a) Chimney Location

The chimney can be placed either on top of the stove or at the back. Usually the decision as to where to locate the chimney was based on convenience. Chimneys inside kitchens had to have an elbow through the wall to the oust outside before turning upwards. The draft worked well with either chimney location. It may prove that over time the buildup of deposits in the chimney will be more problematic in elbow chimneys than in straight chimneys on top of the stove. A downward sloping elbow will allow deposits to run out of the chimney into a hole prepared for that purpose.

b) Plastering.

Early stoves were made without sifting the clay, thus small rocks and other debris were not removed. This debris was causing problems, when the mixture was used as mortar for brickwork and also for plastering. For later stoves the clay was sifted prior to construction. The clean clay provided a better quality finish. One part rice hulls and six parts clay/sand mixture provided a smooth, hard surface with less likelihood of cracking. Where the stove owner was willing to pay for it the stove was plastered with cement, which is likely to provide a more durable surface.

c) Pothole siz

A difficulty with the clay stove is that the pothole sizes must be fixed.. People provided one size of pots during construction, then tried to use a different size when the stove was completed. This allowed smoke and heat to escape. Modifications made after one or two fires usually led to cracking and breaking near the edge of the potholes.

.../.

d) Indoor Stoves

Since the stoves are made of clay, they cannot be allowed to remain unprotected from the rain. Several stoves were built inside kitchens. In one case, a chimney had already been built when the room was constructed. A short metal pipe connected it to the stove. In other houses a hole was madein the wall and the chimney passed through it to the outside.

D. Issues Not Yet Resolved.

1. No equipment was available for accurately measuring the efficiency of the stove models.

2. The current source of the clay/sand mixture is near exhausted, and an alternate source has not yet been located although reportedly there is good clay on the Rusizi Plain and at Kasenyi.

3. As yet we have been unable to test fired clay chimneys and lids due to the difficulty in locating adequate trained potters.

4. The current supplier of the metal parts for the stove has found it necessary to increase his prices. Therefore, alternatives such as fired clay dampers or cheaper metal dampers will have to be investigated further.

5. Baking Place.

   a) A stove (in progress) will be constructed with a place for baking directly beside the firebox, at the same level. A damper will be placed between the baking place entrance and the firebox for temperature control. Controlling the air flow through the damper should provide a suitable temperature for warming food or drying peat.

   b) Baking is possible in the firebox after a long hot fire in the stove, by raking the hot ashes of the peat through the grate, and placing the bread or other food directly on the grate.

6. Fired Clay Chimney and Lids.

Fired clay lids were ordered from potters located in the Bujumbura market. The lids were not fired properly, and it was not possible to set a reasonable price and have it remain the same on delivery.

.../..

Recently contact was made with the Ecole d'Art at Gitega and an order was placed for a clay chimney and lids. Since these items have not been tested, it is not known whether they will withstand the heat of the stove. A tall clay chimney may also be subject to breakage in high winds. If these items are to be supplied by the Ecole d'Art some arrangement will have to be made for transporting them from Gitega.

7. Modified Imbaburas.

A prototype for a modified imbabura has been developed. It has not been field tested yet.

8. Smaller Stoves.

Further experiments should be carried out to develop a smaller, cheaper clay stove moedl. Short clay chimneys of 80 - 100 cm. should be tried on these models.

9. Uncooked bricks.

An experiment should be conducted using uncooked bricks for stove construction, since they are cheaper and may conserve heat better.

10. Local artisans.

A group of local artisans should be identified and trained in stove construction.

11. Plastering.

Other materials for plastering should be tried, such as lime or paint, or another local material.

12. Light metal lids.

Light metal lids for unused potholes could be tried, to further reduce costs. They would also avoid the problems of breakage with clay lids. A brick could be placed on the lid to hold it tight.

13. Modifications for Dampers.

Dampers might be constructed from fired clay or from a single piece of metal with out welding.

14. Non - welded metal chimneys.

To reduce the cost of chimneys, metal could be folded over and banded with wire, or riveted.

15. Bamboo chimneys.

Large bamboos for chimneys have not yet been located. Ijenda and Bugarama have been mentioned as potential sources.

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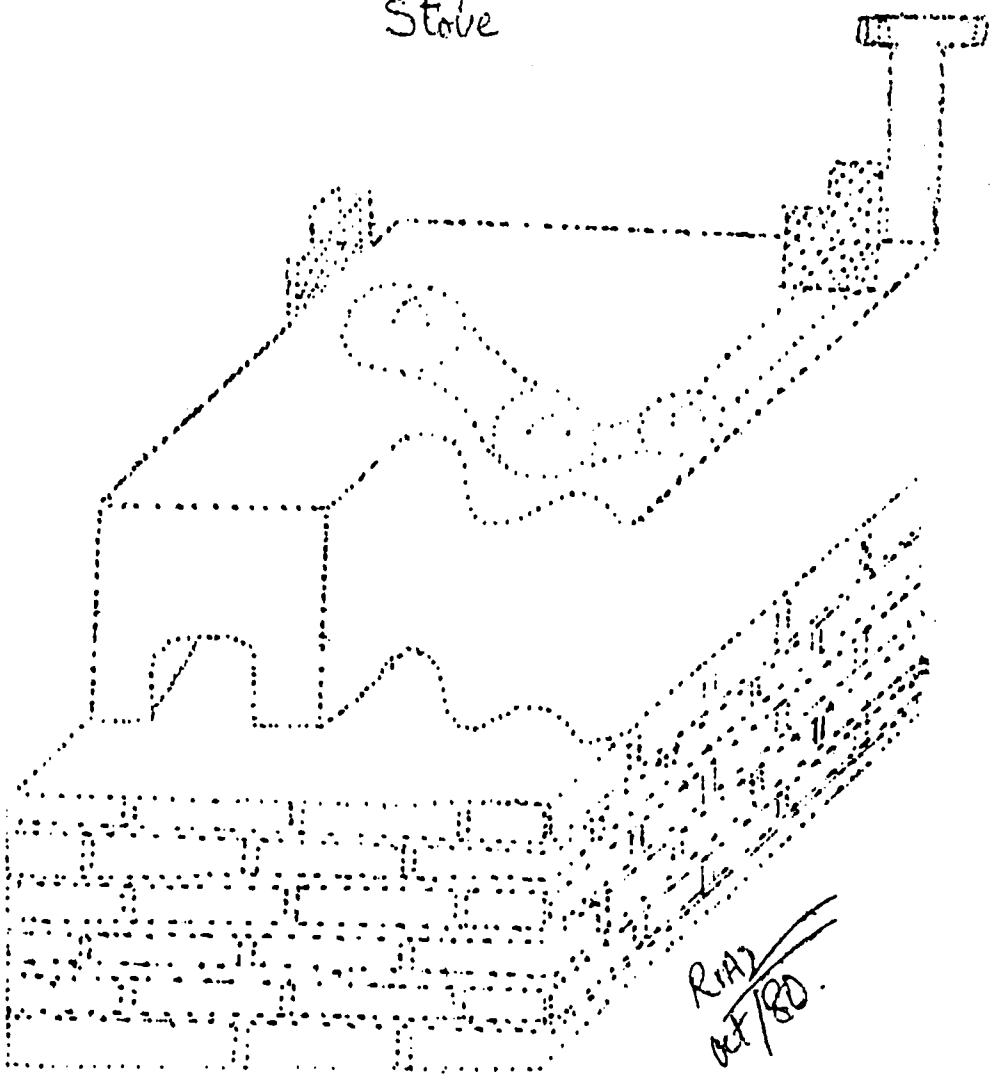
First Experimental
Stove



Drawn by Riaz A. GONDAL

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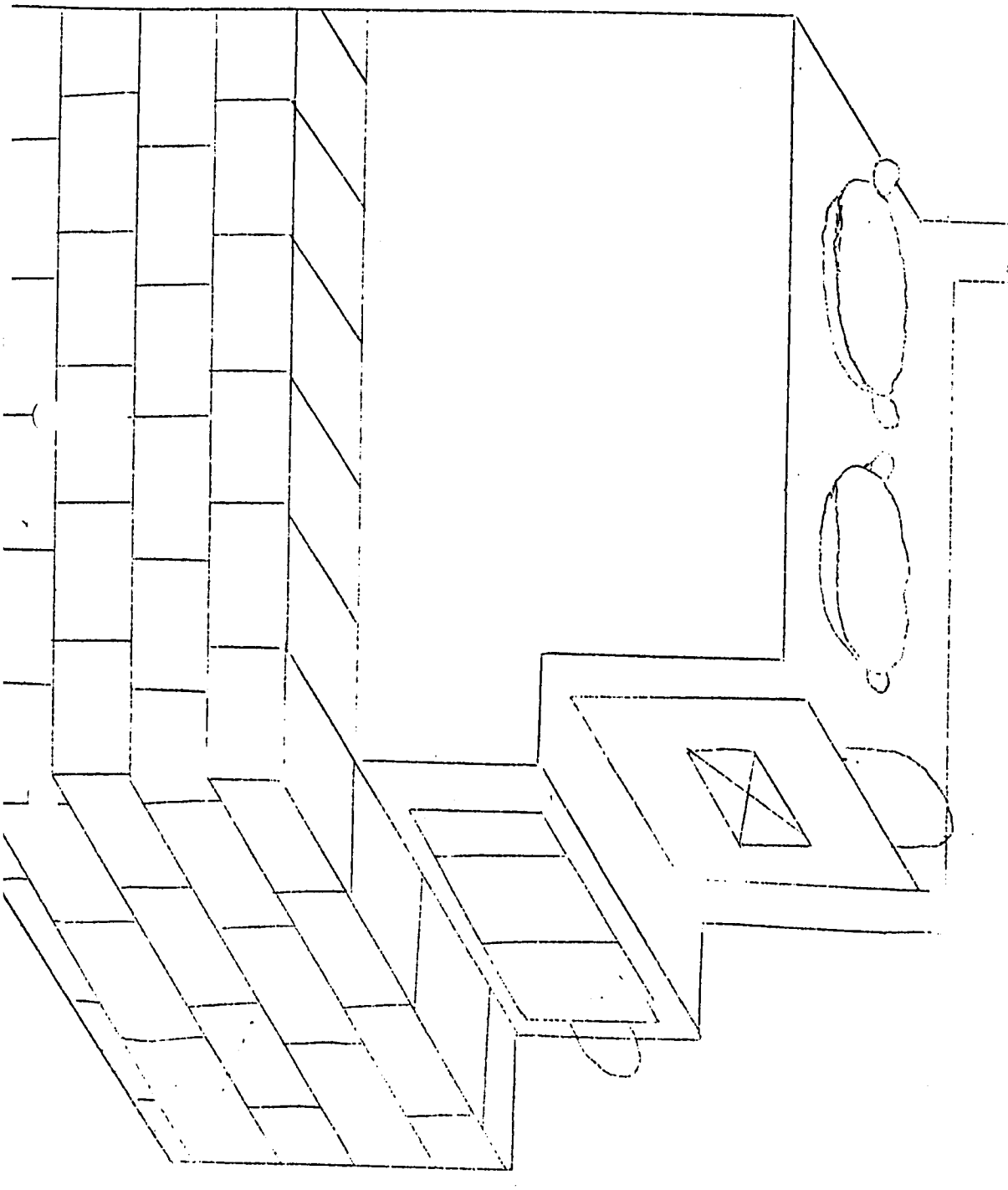

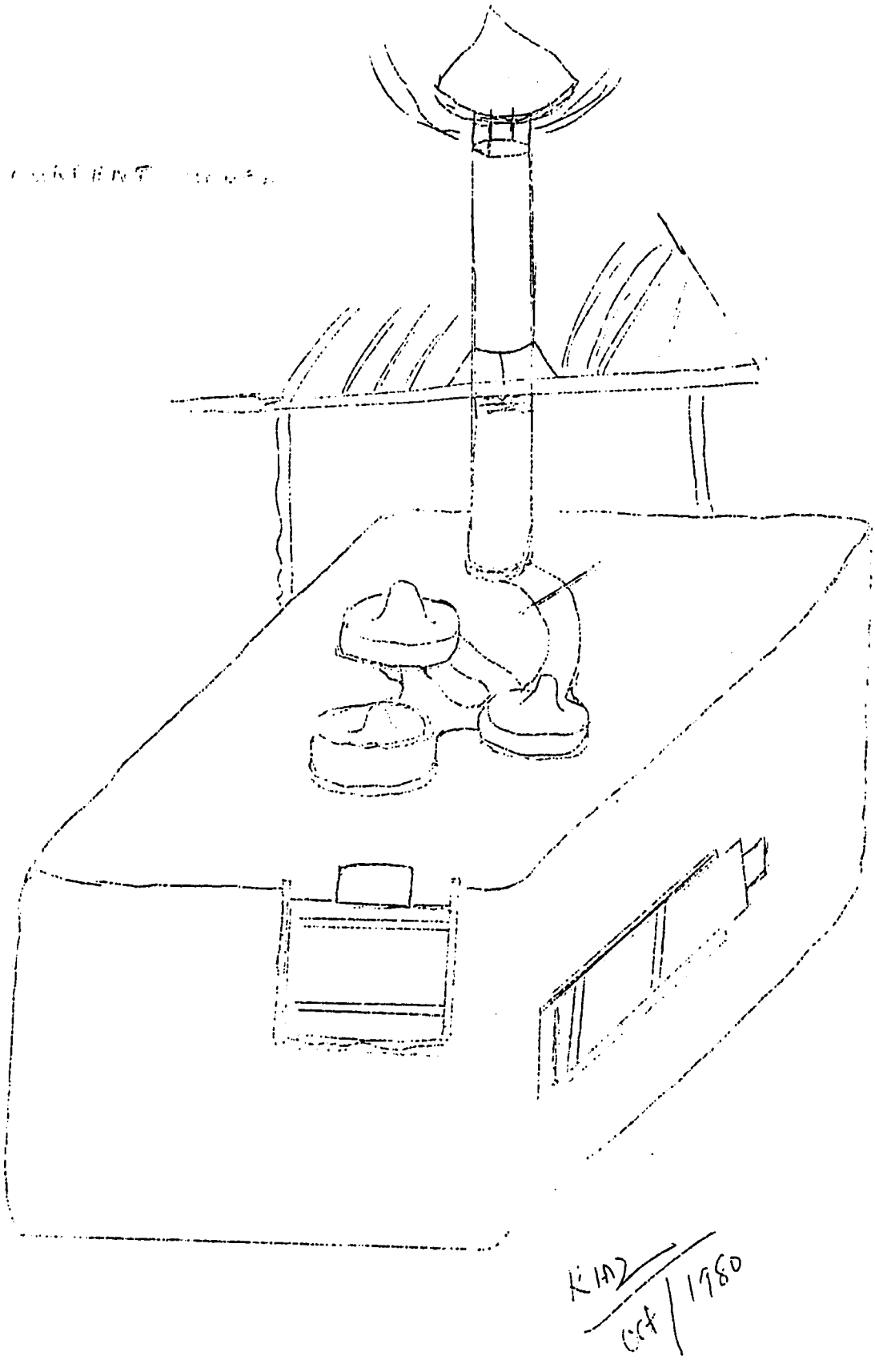

KIAZ
OCT / 1980

ANNEX 1

INSTRUCTIONS WHICH ACCOMPANY THE NEW STOVES.

THE BURUNDI PEAT STOVE

I. INTRODUCTION :

Many countries in Africa, Asia and the rest of the world suffer from a shortage of trees for firewood and charcoal. Prices of those fuels rise and cooking becomes increasingly expensive. One solution is to find an alternative cheap fuel source, another is to make a stove which will use less wood or charcoal for the same amount of cooking.

Burundi is fortunate in that it has extensive reserves of peat. In many countries, such as Ireland, Finland and the Soviet Union, peat is an important fuel source. For two years, Projet Tourbe has been working with the Office National de la Tourbe (ONATOUR) to develop procedures to extract the peat and supply it to users. At present, the army uses peat extensively for cooking, as do several other institutions, such as hospitals.

For several months, we have been working to develop a peat stove suitable for cooking in homes. Using designs from Guatemala, India, Pakistan, Tanzania, Senegal and other countries, we have developed a model stove suitable for testing for household cooking. This stove is an improvement over the imbabura or three rock cooking method because the fuel is cheaper (peat costs less than 200 Frs per sack), and also, since the stove is made of clay, it uses less fuel in a more efficient manner. Modifications can be made in the design to make the stove better to use for the housewife, or to conserve more fuel.

II. CHARACTERISTICS OF THE STOVE:

The peat stove is made primarily of clay and bricks. Clay retains the heat inside the stove so that it can be used for cooking the food. With the imbabura or three rocks much of the heat is lost out the sides or carried away by the wind.

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The stove has several metal parts. There are dampers which control the flow of air through the stove and out the chimney. The fire will burn brighter and faster if the dampers are open. To conserve fuel, the dampers can be nearly closed. Our chimneys are currently made of metal. However, we hope to find a suitable method of making bamboo or clay chimneys which will greatly reduce the cost of the stove.

The stove has a series of tunnels which connect the cooking pot holes. The slope and curve of the tunnels are designed to provide the most heat possible for each pot hole. The pot hole directly over the firebox provides 100% heat, the second pot hole about 60% and the third about 40%.

Lids of metal or clay accompany the stove. They are made to fit tightly over the pot holes, and should always be used to prevent the heat from escaping if you are not using the hole for cooking.

III. THE NEW STOVE :

You should allow the stove to dry about one week after construction is finished. If it is not sufficiently dry it will crack. In the dry season, it may dry more quickly. If your stove has a place for a water can, do not use it until you have made at least one fire.

Your new stove may produce a lot of smoke and steam while it is still damp inside. As soon as possible after the first fire you should clean the inside of the stove with a cloth. Use the stove every day & it will soon be dry and smoke & steam will decrease.

ROOF

You should build a small roof over the stove to protect it during the rainy season. Althrough a metal roof is best, you can make a thatch roof if you put a metal collar around the chimney. You may also coat or paint the stove with lime, varnish or any other suitable local material.

IV. PREPARING THE FIRE

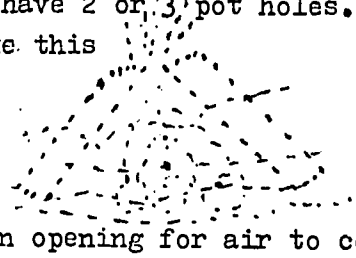
1. First of all, clean all the ashes and cinders out of the firebox and air chamber. Be sure that the grate on which you place the peat is clean.

2. Open all dampers completely, to allow maximum air flow.

3. Make a small fire of paper and soft or broken pieces of peat. You might also add a small amount of wood or dry stalks. You can start this fire with a match or burning charcoal or wood.

4. Once this fire is started, add some small pieces of peat. Fan the front of the air chamber to get the fire burning well. After the flames start, add several peat bricks, perhaps 3 or 4 if you have 2 or 3 pot holes. Stack the peat bricks vertically, like this

Fig.



and be sure to leave an opening for air to come through the grate. You may need to fan the air chamber again until the bricks catch fire.

5. After the fire is burning well, close the air chamber damper completely. If your firebox has a damper, close that too.

The chimney damper should remain slightly open to allow smoke to escape. After 10 or 15 minutes there should be little or no smoke.

V. POSSIBLE PROBLEMS :

A. Excess smoke after the first ten to 15 minutes may be caused by :.

1- Damp peat : The peat can be laid in the sun to dry properly.

2- New stove: Continue to make a fire for several days until smoke decreases.

3- The grate is covered and the air flow through the fire is blocked. Clear a place on the grate.

B. Smoke coming out of the pot holes

1- The pot does not completely cover the hole. Use a bigger pot.

2- Clay has broken away from the edge of the hole. Add a small amount of wet clay where needed.

3. The chimney damper may be closed too far to allow smoke to escape through the chimney. Open chimney damper slightly.

VI. CLEANING THE CHIMNEY

IT IS ESSENTIAL TO CLEAN THE CHIMNEY AT LEAST ONCE A MONTH TO AVOID THE DANGER OF A CHIMNEY FIRE.

Creosote, a burnable liquid or tarlike substance, forms in the chimney and can cause fires in the chimney.. These fires are very hot and hazardous. To avoid this problem, clean the chimney thoroughly once a month. Creosote formation is increased by using wet fuel or by incomplete combustion caused by inadequate air flow.

.../ 5

You can clean the chimney with a stiff brush or a sturdy cloth on a stick. If you have another good idea about how to clean the chimney, let us know. You may find it easier to remove the chimney to clean it. Afterwards, reinsert it, being careful not to block the air flow through the chimney. Pack the wet clay/sand mixture around it and let it dry at least a day.

If a chimney fire does occur, shut off all air entering the chimney by closing all dampers and pot holes tightly. If you clean the chimney regularly, there should be no danger of a chimney fire.

VII. COOKING ON THE PEAT STOVE

Each pot hole provides a different cooking temperature. The hole over the firebox will be very hot. You can use it to fry or to boil food quickly.

Beans can be placed on the first pot hole until they boil and then moved to the second or third pot holes until they are cooked.

Yams or potatoes can be placed directly in the firebox in the hot ashes, taking care not to cover the grate completely.

The pot holes furthest from the firebox can be used to slow cook, preheat (food or water) or to keep cooked food warm.

Unused pot holes can be covered with lids, or with a pot of water. You will make best use of your peat stove by using all the pot holes, even if only to keep hot water handy. The hot water can be used for cooking, for tea or for washing.

..../ 6

It is best to place well-fitting covers on your cooking pots to make more efficient use of the fuel.

If you find you need greater heat in more than one pot hole, you can move a small amount of burning peat from the firebox to the pot hole where it is needed, taking care not to block the air flow in the tunnel. However, this will increase the use of fuel.

Make your own experiments to find the best way of cooking !

VIII. SAVING THE FIRE

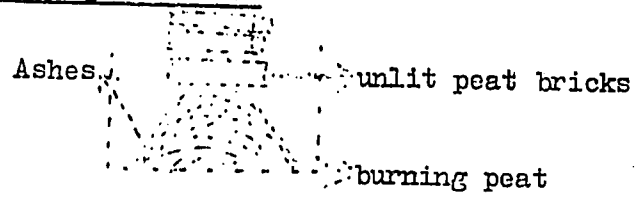
If you finish cooking before the peat is entirely consumed, you can conserve the peat to use for the next meal, up to 24 hours.

Put 2 fresh peat bricks on top of the burning peat. Cover all the bricks and the grate thoroughly with ashes. Close all dampers and pot holes completely to cut off all air.

Note that it is not possible to extinguish the burning peat, like charcoal. Therefore it is better to save the fire and the peat using this method.

Saving the fire

Fig.



IX. CONCLUDING REMARKS:

This is an entirely new stove for peat. We ask for your cooperation in testing it and letting us know the results of your experiments.

Tell us what changes you would like to see in the design of the stove and we will try to make them.

Tell us how you cook on it, what works and what doesn't work.

We would be grateful to receive all of your comments and ideas, and also your complaints, about the stove or abour peat. We would be happy to discuss peat or our stoves with you and your friends.

Riaz Gondal and Cynthia Tobias
Projet Tourbe (ONATOUR)
Tel. 47-44

Mailing address : C/O CRS
B.P. 665
BUJUMBURA

Note : These instructions were translated into French.

40'

CRS/AID/ONATOUR
PROJET TOURBE

C. TOBIAS

PEAT STOVE MONITORING FORM

STOVE N° ..... DATE STOVE WAS READY .....

LOCATION : ZONE ..... ADDRESS .....

SECTION A : The following questions are designed to determine reactions to the stove, and to detect problems with its use which require assistance from project staff. They should be asked several times during the first month.

Date of interview .....

1. How many house holds regularly use this stove ? .....

> NOTE : If more than 1 house hold uses the stoves, ask the questions of 2 or 3 cooks. Clearly describe the residence of each one questioned, so that the same person can be located at a later date.
> Description of residence of person interviewed
> 1A. .....
> .....

2. Have you used the stove every day this week ? Yes ..... No .....

> If the reponse is NO, ask "Why not ? "
> 2A .....
> Give instructions or assistance if appropriate.

3. Which foods have you cooked on the stove this week ? About how long did each of them take to cook ?

.....

.....

.../ 2

4. Did the stove work well for all of those foods ?

Yes ..... No .....

NOTE : If the response is NO, ask

4A. Which foods didn't cook well on the stove ? .....
.....
.....

4B. Why didn't they cook well ?
too long to cook .....
other (Specify) .....
.....
.....

5. Did you use the stove to boil water ?

Yes ..... No .....

NOTE : If the response is Yes, ask

5A. Did it work well ?
Yes ..... No.....
if no, why not .....
.....

5. Did it take much longer to light the peat than it did to light charcoal ? Yes, much longer (major problem) .....
Yes, ...
No .....

NOTE : Mark answer "Major problem" if the respondent voluntarily Offers the information that they do not like it because it takes so long to light, and may not use it because of the time problem. Offer suggestions and assistance on lighting if appropriate.

7. What other materials did you add to get the fire started ?
   Paper products .....
   Wood products .....
   Kerosene .....
   Other (Specify) .....

8. How many times per day do you usually light the peat fire ? .....

9. Does it take longer to cook with peat than with charcoal ?
   Yes, much longer .....
   Yes, twice as long .....
   About the same .....
   No .....

Offer advice if appropriate

10. How many peat bricks did you use yesterday ? .....

NOTE: If a group shared peat and stove, determine how many peat bricks TOTAL were used the previous day . 4A. .....

11. Do you have to add peat more often than you added charcoal while cooking ? Yes ..... No .....

12. Could you keep the fire burning all day by damping it down when not in use ? Yes ..... No .....
    Don't Know/ .....
    Didn't try

13. Did you use charcoal for cooking or heating water this week ? Yes ..... No .....

NOTE: If the response is Yes, ask
13A About how often did you light a charcoal fire this week ? .....
13B Did you put the charcoal in the peat stove or the imbabura ? .....

NOTE : Ask the following questions only if the stove is shared by a group

14. Could you use the stove to cook whenever you wanted to ? Yes ..... No...

15. Who decided when to add peat ?
same person all the time .....
anyone who wanted to .....
group decision .....

16. Have there been any problems with sharing the stove ? Yes..... No.....

If the response is yes, ask
16A. What were they ? .....
.....
.....
/.....

17. Do you like cooking on the stove ? Yes ..... No .....

18. Can you think of any changes to the stove that would make it easier or better to use ? .....
.....
.....
.....

19. Do you like being able to cook standing up ? Yes ..... No .....

20. Will you want to buy peat when the free supply is gone if it is cheaper than charcoal ? Yes ..... No .....

NOTE : When the free supply of peat is about gone, tell people where they can buy more and how much it will cost.

After the free supply of peat is gone, ask the following question.

BI. Have you bought any peat ? Yes ..... No .....

If the response is No ask

B2. Why not ?
Don't like peat .....
Don't know where to buy it .....
Too inconvenient to buy peat .....
Can't afford to buy peat .....
Other (Specify) .....

ANNEX 3.

COST OF MATERIALS.

Metal Parts.

The metal parts have always been the most costly element of stove construction, and will be even more costly if a new supplier cannot be located.

In July, metal parts were supplied at the following prices :

Dampers ..... 200 francs each (all size)
Chimney (2 meters) ..... 100 francs each
Steel plate/lids ..... 750francs each

In October, the prices were increased as follows.

Firebox and air chamber damper ..... 500 francs each
Chimney damper ..... 300 francs each
Ash trays ..... 300 francs each

Chimney (3 meters) .....2,500 francs each
(2 meters) .....1,500 francs each
(1 meter) .....1,000 francs each
Grate ..... 300 francs (approx.)

Other materials costs.

Bricks (fired clay)
Large stove (about 200) ... 1,000 francs
Small stove (about 70) ... 350 francs

Possible alternative materials :

Chimney (bamboo) ..... 30 - 50 francs
(fired clay, 2 meters) about 300 francs
Lids (fired clay) .....150 francs(approx.)

Dampers (fired clay or light metal) .. price not known