Research Report on BACIP Wood Stoves for High Mountain Areas

Designs for Traditional Houses in the Northern Areas, Including Warm Water Facility

By Sjoerd Nienhuys
BACIP Programme Director
Gilgit, Pakistan

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Abstract

Applied research on improved methods for manufacturing traditional sheet metal stoves for cooking and house heating in remote and high altitude mountain areas. Locally available materials and indigenous techniques are used which can be replicated with available skills. Area of application is the Northern Areas of Pakistan (Gilgit, Skardu and Chitral). Improved sheet metal firewood stoves demonstrate improved cooking, reduced smoke emission, better water heating facilities and some firewood saving. Results of field testing and villagers response are included with a list of criteria for stove improvements.

Note:
This document reflects the findings and opinions of the author. It is not an official publication of the Aga Khan Foundation or the Aga Khan Planning and Building Services, Pakistan.
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Drawings by:
Sjoerd Nienhuys
Mubarak Ahmed
Noor-ud-Din
Hussain Ali
FOREWORD

The Building and Construction Improvement Programme (BACIP), operating in the Northern Areas of Pakistan, is a project under the Aga Khan Planning and Building Services, Pakistan (AKPBSP). The programme is financed by PAKSID, a collaboration between the Canadian International Development Aid (CIDA) and the Aga Khan Development Network. The BACIP Programme Director is contracted through the Netherlands International Development Co-operation Programme (DGIS). BACIP works in co-operation with other Aga Khan Development Network Institutions (AKDNI) in the Northern Areas and Chitral, Pakistan. During 1999 and 2000 some 40 staff members, consisting of architects, engineers and social workers, have been involved in the BACIP programme activities. In addition, more than 200 village-based male and female resource persons assist on a voluntary basis in the implementation of the programme.

The present programme (to end-December 2000) consists of the development and introduction of house improvements (more than 40 different types) for traditional and new houses which are useful for villages in remote areas. Technology and skills development among local entrepreneurs has been initiated to enhance the delivery of the house improvements locally. Participatory cluster and village planning is a part of the process as well and community discussions have begun for determining appropriate housing locations to avoid building in geographically hazardous areas. Parallel to these mainstream activities, attention has been given to the design of new schools. As many of the technologies being applied in the new school designs can also be applied in houses, the demonstration effect would have a high impact on the youth and future house builders.

The present report gives an overview of the different types of stoves that have been developed by BACIP. The designs are improvements upon the existing stoves in terms of durability, cost, fuel efficiency and manufacturing techniques. The designs have been repeatedly modified to suit the needs and acceptability of the people.

The BACIP stove (buchari) has been developed on the basis of the AKPBSP (formerly the Aga Khan Housing Board) buchari which was introduced about seven years ago and more than 10,000 installed in the region. The new models have been fitted with various options, such as the top-oven, improved chimney, warm water facility and various chapatti plates for making bread.

The following people have been intensely involved in the development of the house improvement designs, and the testing and realisation of the prototype improvements:

- Mr. Qayum Ali Shah, Manager Field Operations of BACIP, in the manufacturing and development.
- Mr. Hussain Ali, BACIP intern, in making the first computer drawings for the manuals.
- Mr. Mubarak Ahmed, Technical Illustrator of BACIP, in illustrating the use of the units.
- Mr. Abbas Ali, Assistant Architect of BACIP, in making the first prototype models.
- Mr. Zia Ur Rehman, Assistant Engineer of BACIP, in the manufacturing of the stove and warm water facility designs.
- Mr. Iqbal Hussain, Assistant Engineer of BACIP, in guiding stove manufacturers and making manuals.
- Mr. Sher Bahadur, Mr. Nazeem Khan and Mr. Kumail Butt, stove makers in Gilgit, now having plenty of business in making stoves.
- Mr. Mohammad Yaqoob, plumber, in manufacturing the water heating system for stoves.
- All other BACIP support staff without whom the realisation would not have been possible.
- Staff from WWF who have been assisting in promoting some of the BACIP models to the villages.
INTRODUCTION

Most of the BACIP house improvements focus on thermal issues and earthquake engineering aspects. The thermal issues include: smoke control, ventilation, illumination, wall and roof insulation, leakage and dampness control. The improvement of the stoves is an important component of these activities as many of the villagers claimed this as top priority. BACIP required two years (winter seasons) to field-test several improvements and arrive at the current design.

![Figure 1: Ceilings in traditional houses are pitch-black because of smoke and soot](image1.png)

In the past, especially in the traditional houses of the mountain villages, an open three-stone hearth was commonly used for both heating and cooking purposes, with the accompanying smoke filling the room. Smoke and soot emitted by an open fire or a poor functioning stove are not only harmful to the occupant’s health, but blackens the ceiling of the room and makes all items in the house filthy.

![Figure 2: Collection of old stoves](image2.png)
It has been estimated that about 10-20% of the villagers in the region still do not have a stove with a chimney or are not using their stove because it has rusted through. And yet another (undetermined) percentage of the villagers are using the available buchari as an open fire, thus allowing the smoke to fill the room.

**Room Heating Requirements in the Winter**

Generally, the higher the altitude of the village, the longer is the heating season (see table below). Other factors also influence the length of the heating season. For some villages nestled in valleys, the low position of the winter sun means that the sun does not rise above the surrounding high mountain peaks and no direct sunlight is received during the daytime. Night frost will therefore come earlier and the overall need for firewood will be higher than in villages receiving direct sunlight during the winter. Depending on the amount of wind and exposure of some villages, the wind-chill factor will also play a role in the heating requirements. In a number of villages in the higher Skardu region, it becomes so cold in the winter that people do not venture outside for several months.

The following table is an approximation. The (+) symbol indicates the weeks that the night temperature is above 0 degrees Celsius. The (-) symbol indicates night frost. The (=) symbol indicates severe cold at night. A minimum of four hours of daily sunshine has been considered for this table. Shaded valleys or fully shaded building sites have an additional winter month.

<table>
<thead>
<tr>
<th>Village</th>
<th>Altitude</th>
<th>Sept</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May - Aug</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gilgit</td>
<td>5000 ft.</td>
<td>++++</td>
<td>+++</td>
<td>++ -</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>++++</td>
<td>++++</td>
<td>++++</td>
</tr>
<tr>
<td>Ghizer</td>
<td>7000 ft.</td>
<td>++++</td>
<td>++++</td>
<td>++++</td>
<td>- -</td>
<td>-----</td>
<td>-----</td>
<td>- ++</td>
<td>++++</td>
<td>++++</td>
</tr>
<tr>
<td>Skardu</td>
<td>7500 ft.</td>
<td>++++</td>
<td>++++</td>
<td>++++</td>
<td>- -</td>
<td>- =</td>
<td>-----</td>
<td>- ++</td>
<td>++++</td>
<td>++++</td>
</tr>
<tr>
<td>Karimabad Mastuj</td>
<td>7800 ft.</td>
<td>++++</td>
<td>+++</td>
<td>+++</td>
<td>- -</td>
<td>- =</td>
<td>- = =</td>
<td>- ++</td>
<td>++++</td>
<td>++++</td>
</tr>
<tr>
<td>Yasin Passu, Kaplu</td>
<td>8000 ft.</td>
<td>++++</td>
<td>+++</td>
<td>+++</td>
<td>- -</td>
<td>- =</td>
<td>- = =</td>
<td>- ++</td>
<td>++++</td>
<td>++++</td>
</tr>
<tr>
<td>Hoper Gartanz</td>
<td>8500 ft.</td>
<td>++++</td>
<td>++ -</td>
<td>- -</td>
<td>- =</td>
<td>- =</td>
<td>- = =</td>
<td>- ++</td>
<td>++++</td>
<td>++++</td>
</tr>
<tr>
<td>Phunder Tolti, Khaney</td>
<td>9500 ft.</td>
<td>++++</td>
<td>+ -</td>
<td>- -</td>
<td>- =</td>
<td>- =</td>
<td>- = =</td>
<td>- ++</td>
<td>++++</td>
<td>++++</td>
</tr>
</tbody>
</table>

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Firewood is regularly collected during the entire summer and autumn period. However, in the month of October villagers make weekly expeditions to the mountains to collect sufficient firewood to last the entire winter. For the highest villages, the month of September is also devoted solely to firewood collection.
1. FIREWOOD SAVING

The sketch below gives an impression of the central position of the stove in the traditional house of the Northern Areas. The stock of firewood is kept in the lower right-hand corner of the room (6-10 m³). Cooking is usually done on the left-hand side of the stove as can be seen in figure 22. Because the chimney is placed through the open traditional roof hole, it actually accelerates the outward movement of hot air. Closing of the roof opening is therefore the first intervention necessary to reduce firewood consumption.

**Figure 6. TRADITIONAL HOUSE DESIGN – 18’ TO 20’ SQUARE WITH NINE SECTORS**
The main objectives of reducing firewood consumption are to lessen the tremendous workload of the people in collecting the annual quantities required and to preserve the local forest environment.

Although the people demanded better stoves (more heat, less firewood), initial investigations revealed that high firewood consumption was mainly caused by the design of the traditional house with its open roof hole through which all the warm air escaped (along with the smoke). Air movement is stimulated by the central position of the roof hole and the fact that the ceiling raises towards that hole, thus allowing the warm air to collect easily at the top (see figures 1 and 6).

When the warm air leaves the top opening (along with the smoke), cold air immediately enters into the house through the same opening, mixing with the smoke and warm interior air. This action is caused by the lack of any other ventilation opening in the room for entry of air. Traditional houses often have no windows and, if it is cold outside, the door is kept shut.

By closing the roof hole, the escape of warm air and the flow of cold air into the room can be prevented, but a chimney is required to evacuate the smoke. In addition some ventilation at the top side of the ceiling is needed to further evacuate residual smoke. To allow a controlled air flow, other small ventilation openings which can be regulated need to be created in the lower part of the room. The design of the BACIP Roof-Hatch Window was the result. The roof-hatch window can reduce up to 50% of the heating requirements. Reducing the need for firewood automatically reduces the amount of smoke emitted by the fire.

The above-indicated traditional house design is very common and so are the living and cooking behaviour in these houses, including the central position of the stove. If the BACIP programme would have tried to change the layout and use of the house, in addition to the equipment, it would have generated strong resistance and been impossible to implement. Separate actions were therefore undertaken, one was to install the roof-hatch windows and another was to look at the possibility of improving the stove.

![](image)

**Figure 7.** Roof-hatch window controls the air flow (reduces firewood)

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1 See the BACIP publication entitled *Research Report on the Roof-Hatch Window* (May 2000) for precise information on the high insulation effect of the application of the roof-hatch window.
Other measurements to reduce the need for firewood during the cold season are mentioned in the following figure, the most important measurement indicated as number one. For the type of houses found in the Northern Areas, eight levels of thermal improvement can be identified$^2$.

FIGURE 8. EIGHT LEVELS OF INTERVENTION TO IMPROVE THERMAL INSULATION

FIGURE 9. FIREWOOD SAVED IN ONE WINTER WITH THE ROOF-HATCH WINDOW

$^2$ See the BACIP publication entitled *Wall Insulation Techniques for Buildings in High Mountain Areas* (September 2000) for more information about the different methods for insulating traditional houses.
2. BEFORE BACIP INTERVENTION

The first house improvement introduced (1987-1993) was the buchari with a chimney, which aided in evacuating most of the smoke. Although this stove saved some firewood during cooking, the actual saving was reduced due to the position of the chimney.

When comparing the metal-sided buchari with an open hearth, the firewood saving for cooking purposes is in the order of 20-25% owing to the fact that the fire is concentrated under the cooking pots (measurable). The chimney, however, goes straight upwards from the buchari through the open hole in the centre of the roof. That hot chimney pipe creates warm air around itself and gives an additional force to the airflow alongside the chimney, straight out of the roof hole. The result of this process is that the "smoke-free" buchari helps to remove the warm air (it creates itself) out of the room, thereby considerably reducing the effect of the heat gained. Especially if that buchari is used for room heating, it is hardly more efficient (in terms of firewood consumption) than the open hearth. The advantage is, though, less smoke.

When examining the options for improvements, it was clear that changing the location of the buchari, as well as the cooking methods and the roof hole position, would have been too drastic for most villagers and cause resistance to change. Closing the roof hole and otherwise reducing the amount of firewood had first priority. Once the credibility of the BACIP interventions was established, other improvements could be introduced.

The type of buchari that was selected and promoted by the Aga Khan Planning and Building Services, Pakistan (formerly the Aga Khan Housing Board) in 1993 was a tremendous improvement in comparison to the open fire (open hearth). Over 10,000 units were placed in the villages and since then the local metal sheet workers have been replicating the design, sometimes with small modifications. By confining the sides of the fire by means of the metal sheet of the buchari, the heat of the fire is directed more upwards. As a result, the cooking pot or a chapatti plate is heated more efficiently. At the same time the thin metal sides of the buchari still radiated heat for warming the room. The design promoted by the Housing Board had two top holes, one 16 inches in diameter and one 6 inches to accommodate a smaller pot (see figure 10). Behind these two holes a chimney was fitted that went straight up, out of the roof through the open roof hole. The metal buchari, as compared to the three-stone open hearth, not only saved about 5-10% firewood, but also greatly reduced the amount of smoke in the room.

FIGURE 10. HOUSING BOARD BUCHARI IS IN USE BY ABOUT 75% OF THE HOUSEHOLDS
3. RESEARCH AND DEVELOPMENT OF BACIP BUCHARI’S

USER CRITERIA NUMBER ONE: LOW COST, USE OF LOCALLY AVAILABLE MATERIALS

Solution A: Low-Cost BACIP Clay-Soil Stove

The first initiative of BACIP was a stove design that was both low in cost and low in firewood consumption. A design was made and field-tested of a two-hole compacted clay-soil stove along the principles applied in Honduras and Guatemala (estufa lorena). Instead of placing the soil construction on an elevation to allow cooking while standing (Central American model), this more rectangular-shaped two-hole stove was placed lower, on the ground, as most women attend to the buchari sitting in a hunched position to the left side of the stove (see figures 22 and 25). The stove had the required two conditions (very low cost and firewood saving). It was fitted with a metal top plate to reduce wear and allowed the making of chapatti’s in the front part, and a hole for a cooking pot in the rear.

To facilitate manufacturing and easy installation (casting/compacting) in the houses, a wooden mould was made that could be assembled on the spot. Once the soil inside the mould was firmly compacted, the mould could be removed and the holes adjusted with a knife. With the application of some soft wet clay, the top plate was then pressed in place. A test model in the quarters of the BACIP watchmen revealed that the front extensions needed to be either reinforced with wire-mesh or had to be omitted altogether. The final design had a one-piece, top-front plate without front extensions.

![Figure 11. Picture of wooden mould](image-url)

The above-depicted mould can be disassembled by lifting the pins in the corners. In this way the four side components and the core can be easily transported from one place to another.
The first clay-soil stove design installed in a village was rejected by the villagers because of the following four important reasons:

- The body was made from compacted clay-soil and considered having a low social status. This is very much related to the fact that all other stoves are of metal, either metal sides fitted to a soil foundation or including a metal bottom. The women just did not want a clay-soil body stove in the house.
- Before installation, the advantages and disadvantages were not properly explained to the users. The freshly compacted clay-soil stove requires several days for the body to dry out completely before it can be used effectively. Thus during the first week even less heat can be produced. By not explaining that point, the house owner was very disappointed that the stove did not give instant heat.
- The installation by the BACIP staff was not very neatly executed and rather sloppy (stones of the foundation were sticking out).
- The clay-soil body was so insulating that little or no heat radiation occurred through the sides, thus not heating the room at all. The design was mainly a cooking stove and ineffective as a room heater in the winter. As the installation was done in the cold of winter, it did not serve the objectives of the villagers.

In addition to the above observations from the villagers, it appeared to be difficult to get the correct clay-soil mixture in each village as soil conditions varied largely from one valley to another.

The clay-soil stove design, however, appeared to be useful for the hotter climate regions in Pakistan and some of the elements of the design (mould, material and working method) were adapted for the Sindh region.

The condition of the people was therefore not only that the stove should be cheap and save on firewood, but it should also warm the house in the winter by massive heat radiation. These two conditions are contradictory. Saving firewood and large heat radiation are two opposing conditions that could hardly be met at the same time in a simple low-cost design. Thus, two types of stoves were designed: one that would save firewood and one that would radiate heat.
**Solution B: BACIP Stove with Interlocking Brick or Stone Sides**

The clay-soil body stove was redesigned with interlocking burned clay bricks along the sides, using the same metal top plate. This made the stove more presentable and easier to assemble (no difficult mixing and testing of soil, or the use of a mould). This stove was only recommended as a second summer stove for use outside the house. The special advantages of this summer stove are:

- Considerable firewood saving (20-30%) as compared to the three-stone open hearth (when cooking).
- A simple design with only a few straight folds in the metal top plate.
- The possibility of a thick top plate (gauge 16 = 1.6 mm) and therefore more durable.
- A top plate only (not the sides), thus saving metal and keeping the cost low.
- An almost loose top plate that could be stored away in the winter.
- The possible substitution of the bricks with dressed stones, lowering the cost.

The disadvantage of the brick-sided summer stove was the difficulty in obtaining the interlocking bricks in the Northern Areas. These brick had to come from Rawalpindi or further (700 km). Several brick manufacturers indicated that they could easily make the bricks, but they would need an order for at least one full truckload.

![Figure 13. Stove with interlocking bricks along the side](image)

The following two diagrams show how the heavy duty stove top is placed on a stone foundation. When the mason was shown how to make the stove with brick sides, he concluded that he could cut stones accordingly, thus saving the cost of importing the bricks. For a courtyard summer kitchen stove, this is an option which is definitely cheaper than imported bricks. However, the thermal insulation of the stones will be less than the bricks. As is shown in the diagrams, the inside of the summer stove is elevated towards the chimney to force the fire along the top of the plate.

![Figure 14. Placement of the single stove top on a stone foundation](image)
USER CRITERIA NUMBER TWO: LESS SMOKE IN THE HOUSE

In assessing the requirements of the villagers, the most prominent problems identified are the cold in winter, the large amounts of firewood used and the difficulty in keeping the house warm. Related to the large amounts of firewood used, is the smoke from the wood-burning fire.

The smoke is caused to a large extent by the (incorrect) use of the buchari. Instead of placing small pieces of wood through the door opening, the buchari is invariably being fuelled from the wide open top. Thus, the initial burning emits large amounts of smoke (moist materials) into the room.

Lesser smoke could be achieved by six related measurements:

- Allowing larger pieces of wood to be placed through the door instead of through the wide open top.
- Reducing the wide open top (16") with a smaller opening (12").
- Assuring that only dry wood and grass be used for initiating the fire.
- Reducing the need for large amounts of firewood by insulating the house.
- Improving the chimney or hood above the stove for better evacuation of smoke.
- Using a thicker steel plate that provides a better closure of the lids.

Obviously by reducing the need for heating, the need for burning firewood would be reduced and this would consequently reduce the amount of smoke.

**Solution C: BACIP Straight Metal Stove**

The above six criteria were translated into a straight-looking model that could be made of a thicker metal sheet steel plate than the common buchari, thus giving it a longer life time. The thicker steel plate is in the long term cheaper than the thin-plated buchari. A straight model was required to simplify the manufacturing with the thicker steel plate. Several models were made with a fixed concave chapatti area and another model with free-standing legs. The stove was well accepted and placed in several villages for field-testing.

![Figure 15. Straight-looking (thicker metal) BACIP stove on legs and with ash collection tray](image-url)
USER CRITERIA NUMBER THREE: LESS FIREWOOD USE

Although the demand for less firewood use would primarily be served by closing the open hole in the traditional roof and insulating the house as indicated above, both the villagers and some NGOs insisted that the stove should also use less firewood. After developing the highly effective insulation techniques, because they were most important, attention was given again to the stove design.

The reduction of firewood through an improved stove design is difficult when the stove is to be used for room heating. As previously indicated, part of the improvement may be linked to the location of the stove. Technical options are in designing an improved heat exchange mechanism between the stove and the air of the room and in the design of the chimney. For the construction of a stove with a longer heat exchange track, or a flat and extended chimney, or a heat/air exchanger attached to the chimney, extra metal sheeting would be required. Also the additional work of the sheet metalworker would increase the cost of the stove and piping. Together, additional investment would be required for the purchase of such an improved stove, against only little enhanced efficiency. As a result of the discussions with the target population, it was very clear that adding a heat exchanger, and with that increasing the cost of the stove, was not an option.

The reduction of firewood in the summer is another situation altogether because in the summer the stove is needed only for cooking. Heat emission through the thin metal of the current buchari design is so high that often cooking is done in outside kitchen areas during the summer to avoid the heat. However, in these kitchen areas most families use the three-stone open hearth which consumes large amounts of firewood. In a few cases the house buchari is placed outside.
Solution D: BACIP Metal Stove Lined with Terracotta Tiles

By insulating the BACIP stove with terracotta floor tiles on the inside, the heat does not radiate sideways and a saving of firewood is achieved. An advantage of placing the terracotta tiles on the inside is that it does not affect the “good-looking” outside metal of the stove, this being an important criterion for the user. In winter, however, the terracotta tiles must be removed to allow heat radiation from the sides of the stove for heating the room. This is especially important in houses where no insulation has yet been applied. The design developed by BACIP is a stove in which the terracotta tiles can be placed for the summer to prevent radiation and removed for the winter to allow room heating.

For easy placement and removal of the terracotta tiles, the sides of the stove were kept straight. To keep the length of the stove as short as possible (for two holes and chimney), a combination was made between tiles that were 8" x 8" (20 x 20 cm) and tiles of 3.5" x 8" (9 x 20 cm). Both sizes of floor tiles are commercially available in the market. As the height of the tile was 8 inches (20 cm), the stove was made 8-1/4 inches high or 21 cm. The tiles were kept in place with clips, pieces of steel metal stapled to the top plate. The internal height of the stove was similar to the large traditional buchari and allowed for baking of the traditional bread inside the oven.

With the tile placed in the summer, firewood saving is about 25% as compared to an open hearth outside the house and about 10% as compared to the use of the metal stove without the tile lining. These percentages are estimations for summer wood consumption. Assuming that the total wood consumption during summer is about 1000 kg. for cooking, the saving realised can be at least 100-200 kg. Placing the tiles in the summer has a special comfort benefit for the user (less sideways heat radiation).
During the testing period of the model stoves, it was observed that the terracotta tile lining allowed for a good flow of the fire towards the narrower end of the stove and out the chimney, causing increased firewood consumption. To reduce the fast rearward flow, a baffle was inserted between the middle tiles. The opening in the baffle was large enough to pass a tile from the front top opening diagonally towards the back. This made it possible to place and remove the tiles when the stove was fixed to the floor. Otherwise the stove would have to be lifted in order to change the tiles for the seasons.
USER CRITERIA NUMBER FOUR: INCREASED DURABILITY

As indicated above, the cost of the stove should be low. Therefore the stove must be easy to make by local metalworkers using only simple tools and locally available materials. The cost of a product can be defined on the basis of the total purchase value of the new product or on the basis of the overall cost of the product over the lifetime of that product. In several villages in Chitral a heavy metal stove was found that lasted more than ten years. For making most of the normal buchari’s, recycled oil drums (gauge 21 = 0.8 mm) are being used. These buchari’s usually burn through (rusts through) in four to five years, depending on the quality of the metal. For the cheapest buchari, low-quality recycled tar barrels (gauge 23 = 0.6 mm) from road construction are being used, lasting only three to four years. As indicated above, the low cost of the buchari is for most villagers a very important aspect.

FIGURE 20. LATEST DESIGN OF BACIP STOVE

Steel Sheet Thickness

It was found that most metalworkers did not have welding equipment and connections of the stove plates needed to be made by folding the metal sheet. The thickest metal sheet that could effectively be joined by the folding technique was the gauge 18 (1.2 mm) mild steel sheet. At the same time this is also the thinnest sheet that could be welded with electric arc-welding.

Increased Durability, Lower Cost

The advantage of the gauge 18 metal sheet was that it gave an estimated stove life span of eight to ten years with only a 50% price increase. The straight-edged BACIP model requires only little manufacturing time and has very limited wastage of metal sheet. If the BACIP stove is lined with the terracotta floor tiles, the lifetime may be even longer; thus making the BACIP stove\(^3\) in the long run much cheaper than the current thin buchari.

\(^3\) For a complete overview of the BACIP tile stoves, a detailed manufacturing manual is available.

BACIP, Stoves Research Report (November 2000) 16
Figure 21. Heavy duty, square-shaped metal stove in Chitral with side basket for heating bread.

Figure 22. Open chapatti fire and higher water pot.
USER CRITERIA NUMBER FIVE: WATER HEATING FACILITY

As the buchari’s are often fired for extended periods (to warm the house), a water kettle is usually placed over the second hole to have warm water when needed. Women appreciate having warm water for various household purposes: washing the dishes, personal hygiene of the family members (especially toddlers) and washing clothing. In the absence of warm water, such activities are undertaken using either ice-cold river (nala) water or tap water in the yard, if available. Even if tap water is available at a short distance from the house, the temperature of that water in the winter is almost at the freezing point.

Solution E: BACIP Stove with Warm Water Facility

The installation of a warm water facility is therefore not considered as a luxury, but a basic need for general household and hygienic purposes. A potential problem of the installation of a warm water facility inside the traditional house is the disposal of the waste water.

Currently the BACIP programme is assessing the following points in relation to the installation of the warm water facilities:

- Best location of the water barrel in the house and length of the connecting hose.
- Caption and evacuation of leaking or splash water.
- Organisational or architectural aspects of the kitchen organisation.
- Method of alimentation of new water into the storage facility (barrel).
- Required capacity of the storage facility.
- Pipe diameter and necessity for insulation of the container.
- Insulation and protection of the water pipe to and from the storage container.
- Additional firewood use because of the water heating facility.
- Impact on the household organisation and workload of the women.

![Figure 23. Pipe attachment is fitted under the top sheet of the stove](image-url)
Apart from the ongoing social and economic assessment within the houses, the technical structure of the water heating facility with the use of the stove has been adequately solved. The pipe attachment (inside) does not obstruct the use of the stove and can be built into all BACIP stove designs without modifications to the metal body. Currently three sizes of storage containers are being used (80, 130 and 200 litre), from which the 130 litre barrel seems to be the best size for placing in existing houses that do not have an in-house water connection.

For making a permanent water supply to the storage container, the use of a toilet ball-float for automatic filling is NOT recommended. The quality of the locally manufactured ball floats is rather poor and often starts leaking. This may cause overflowing of the barrel. The use of a water tap that is manually opened and closed has less risk of causing a flood.

The piping system for inside the stove is either made from straight pieces of pipe with two elbows or from one pipe that is bent. The advantage of bending the pipe is that the construction is cheaper, but a pipe-bending tool is needed to avoid that the pipe folds and becomes damaged. The disadvantage of bending the pipe can be that the thinnest and cheapest quality pipe is used to realise the short bend. The three-piece construction needs to be used for the thicker quality pipe. However, it can be assumed that the local plumbers (to cut costs) will also use here a thin pipe quality.

BACIP will need to specify what pipe quality is required (thickness). However, it will take several years to find out which quality of pipe will burn through first or after how many burning hours. This is part of the ongoing research.

The straight (long trapezium) design of the BACIP stove only reached its current shape after the warm water facility was tested and applied. To keep the construction simple for the installation of the ceramic tiles, as well as for the piping, the sides needed to be kept straight.

For reason of improved comfort, the warm water facility is very popular with the villagers and apparently the cost is no obstacle for its purchase. This demonstrates that when the comfort level is considerably increased, the price a person is willing to pay rises (affordability).
USER CRITERIA NUMBER SIX: MAKING CHAPATTI’S

The popularity of the Housing Board buchari was related to its appropriate design and the fact that the villagers were already accustomed to its use before promotion. The chapatti is the staple food in the Northern Areas and large amounts of these unleavened bread pancakes are made on a daily basis. The large concave chapatti disk is often 18 inches (46 cm) in diameter and made from gauge 14 (2 mm) metal. The plate fits over the large opening and allows three flat breads to be baked at the same time, thus reducing the baking time, as well as reducing the time a high fire is needed for the baking process.

![Figure 25. Large round concave chapatti disk for making three taltopays](image)

One of the objectives of the stove improvement, however, was to reduce the size of the larger cooking hole to prevent the user from stoking the fire through the top opening (which consequently emits large amounts of smoke into the room). After numerous consultations with villagers, the opening was reduced to 12 inches (30.5 cm). Women having larger families, however, then complained that the large round chapatti disk did not fit over the opening and smoke came out from the sides due to the trapezium shape of the BACIP stove.

**Solution F: BACIP Stove with Improved Chapatti Plate**

To resolve the need for a larger chapatti-making surface and the problem that the round disk did not fit over the square-shaped BACIP stove, a special chapatti top plate was designed that fitted over the entire width of the stove and locked into a groove in the middle of the stove. The construction eliminated almost all smoke escaping from under the plate. However, the plate needed to fit exactly on the stove. As the stoves are individually made by local manufacturers (and not mass produced), not all stoves are of equal size. Thus poor fitting often resulted.
Two solutions were found:

- One longer trapezium-shaped *chapatti* top plate that covered both the holes (12" and 6") at the same time. This provided extra surface, although the *chapatti* in the front (above the wider opening) would cook faster than the one over the smaller hole. This, however, is considered an advantage.

- One round concave disk fitting exactly in the 12-inch hole (rather smoke-free), but extending to the 16-inch width of the stove and allowing for larger *chapatti’s*. It was found that the plate or the disk should be provided standard with the stove so as to assure proper fitting.

With the upgraded design of the stove using terracotta tiles on the inside, the sides of the stove were made straight over the entire length. The *chapatti* plate could then be made as a simple straight trapezium, thus always fitting on the top of the new stove (see drawing below). The optional round *chapatti* top has a low ring welded under the concave top to improve the closure between the stove top and the plate.
In Chitral area, it was observed that two open fireplaces were being used, one low one for making chapatti’s and one a step higher (behind the first fireplace) where a large water pot was permanently placed. The *chapatti* cooking is done over a hot fire (emitting large amounts of smoke) while the water heating is rather a continuous process and linked to room heating. When the family was issued with the BACIP straight model stove, rather than placing this where the two existing fireplaces were, the BACIP stove was installed on the side of the room. Apparently the woman of the house did not want to change her behaviour of cooking four to five small *chapatti*’s at one time on the large disk. Her argument was that the smaller BACIP stove with a smaller *chapatti* cooking surface would require her to spend more time by the (hot and smoky) fire baking the large pile of *chapatti*’s required for her 28-member family (figure 22).

The newest model BACIP stove with an enlarged and longer *chapatti* surface and the incorporated water heater was considered as an advantage and with this combination the women was convinced of changing her cooking behaviour. With the new stove no smoke is produced, so there is no hurry to finish the work fast. The front of the new BACIP stove is used for cooking, while the rear side is used for keeping them warm after cooking. In addition the new BACIP stove made warm water at the same time, possibly saving firewood⁴ as compared to the former situation of figure 22.

**USER CRITERIA NUMBER SEVEN: OVEN AND BAKING**

Traditional bread is baked in the *buchari* using a round metal cooking pan with a lid. The entire cooking pan is placed in the hot ashes after the cooking process and only a glowing fire is maintained (see figure 17). In several hours the heavy, thick bread is ready and the pan removed from the *buchari*.

Whether this bread can be baked in the new BACIP stove depends on the size of the baking pan. The pan should be smaller (including the handles) than the 12-inch top opening because the front door is too small.

As an alternative to using the inside as an oven, the stove can be fitted with a top-oven. This is a double walled container that is placed on top of the *buchari*, thus receiving heat from below. The container is about as high as wide. Due to the double wall construction, the heat will be contained and will keep food warm or slowly bake bread. The amount of heat in the top-oven depends on the fire below, as well as the placement of the closing lid over the hole. Direct contact between the inside cooking pot and the stove can be reduced by placing a zigzag-shaped separator ring under the pot. A top-oven can be manufactured either for the second smaller hole or the larger front hole. Even after the fire is extinguished, the top-oven will keep the food warm due to its insulating capacities.

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⁴ When additional amounts of water are heated for comfort reasons, firewood consumption will also increase. Considerable firewood reduction can only be achieved with thermal insulation measures.
Because the sides of the new stove are now similar for all models, being a 29-inch long trapezium with a base of 18 inches and a top of 6 inches, the top-oven will fit on all stoves and be smoke-free.

For making the top-oven, it was not the stove metalworkers who were contacted, but rather the tinsmiths who make the travel trunks and storage suitcases of thin galvanised sheet steel. The art of marketing the top-oven lies largely in the skill of the tinsmith to make a good-looking product. In addition BACIP needs to provide in the future a mini-cooking book that would explain how to make best use of the top-oven for either cooking or keeping food warm.

**Other Attachments – Temper and Ash Collection Tray**

To reduce the exit flow of air after the fire is extinguished, the chimney can be fitted with a temper. This temper, however, should not be used to lower the fire as this will result in smoke being forced into the room.

In a number of cases the villagers were interested to buy an ash collection tray that would fit in the front of the oven. The ash collection tray is particularly useful for those ovens with legs. The tray is used for removing the ash, as well as for keeping the supply of kindling wood off the floor.

**USER CRITERIA NUMBER EIGHT: ROOF PASSAGE AND FERI-FERI**

To remove smoke from the room, a gauge 28 (0.38 mm) sheet metal chimney pipe is used. The chimney pipe is made either from plain sheet steel or galvanised sheet steel. The chimney gets very hot and contributes to the heating of the room. This means that the longer the chimney, the more it will contribute to warming the air in the room.

If the chimney goes straight upwards through the open roof above the buchari (see figure 1), the same will contribute to the cooling of the room because of the accelerated upward airflow alongside the chimney. Considering this airflow, it is recommended that the chimney makes two bends before it leaves the room through the roof (see figure 29 below). The bends can be of 90 degrees as pictured. However, it is preferred to have two bends of 135 degrees to assure a better smoke flow through the chimney.

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5 Wood ash is used to mix with cow dung or dry composting toilets to improve the compost quality.
It must be taken into consideration that the chimney will become full of soot and tar during its use, depending on the wood material used. The chimney therefore needs to be cleaned out every year; otherwise a chimney fire can occur.

**Chimney Cleaning Brush**

For cleaning the chimney, BACIP has made a chimney pipe cleaner consisting of a toilet brush fitted onto a 4-foot long wooden stick. Obviously, it is necessary to clean the chimney well away from the house and when there is no wind; otherwise the light soot will make everything dirty.

**Roof Passage**

The roof passage designed by BACIP is a square sheet metal pipe. The 3-inch round chimney pipe fits inside and creates a space between chimney and passage. The advantages are: (1) it will prevent the roof catching fire in the event of a chimney fire, (2) the space between the chimney pipe and the roof duct allows for a slight ventilation which will suck any residue smoke from the ceiling region out of the room and help keep the room smoke-free, and (3) the roof passage is fitted with a skirt that makes the connection with the roof waterproof.

![Image of Chimney Cleaning Brush and Roof Passage Diagram]

**FIGURE 30. FERI-FERI AVOIDS SMOKE BLOWING BACK INTO THE CHIMNEY**

**Feri-Feri**

The Feri-Feri\(^6\), copied from an existing European design, was the first BACIP improvement that was realised in 1998. The top wind fan is fitted on a curved sheet that partially covers the opening of the chimney pipe (see figure 30). Backdrop of smoke into the chimney pipe is avoided because the wind fan turns the opening below the cover piece away from the wind. This is important because most chimneys do not extend high enough above the roof. The flap in the holder was a later addition when testing revealed that in some models the bolt supporting the pivot bar dropped into the chimney. The Feri-Feri is made from gauge 26 (0.45 mm) galvanised sheet steel.

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\(^6\) The name Feri-Feri means “crazy” and is the name the villagers gave to the gadget because it turned around like crazy when whirlwinds caught the fan.
4. BACIP WORKING METHODOLOGY

The development of the BACIP buchari’s illustrates that merely designing a stove is not enough. During the research phase to find a better solution for the most practical stove given the local situation, the BACIP team had to examine and consider:

- The technical aspects of the current use of the existing heating equipment and type of firewood.
- The cooking and heating behaviour of the people in summer and winter.
- The differentiation of several heating and cooking options in summer and winter for food and water.
- The possible attachments to the equipment for providing optimal comfort.
- Planning of the location of the stove, house planning and modified kitchen arrangements.
- The ability of the local craftsmen to manufacture the components.
- The ability of the villager or local handymen to install and maintain the equipment in the villages.
- The affordability of the people, comparing savings and local access to credit or finance.
- Possibility of transport and potential damage during transport.
- Methodology of ordering, payment and delivery to remote villages.
- Communication methods with remote villages in local languages and with illiterate persons.

The stoves developed by BACIP are designed on the basis of simple technologies used by the local metalworkers and the availability of the most common local materials (mild steel sheet). The tools and technology of manufacturing are simple and holes are cut with a cold chisel. Folds and connections are made on a straight rail using various hammers. Some metalworkers have electric
welding equipment, but electricity supply may only be available for a few hours per day in the larger villages.

**Demonstrations in Village Houses**

BACIP has placed demonstration models of the designed house improvements in several houses in selected villages, a different stove type in each house. In doing so, BACIP staff could:

- Spread the expenses of the villager’s participation for the installation of the model improvements over a number of villagers from different villages.
- Analyse the effect of a single improvement on the habits of different families.
- Compare similar improvements between villages at different attitudes (from 6000 ft. to 9000 ft.).
- Obtain measurable and comparative data about the house improvements.
- Modify the house improvement depending on the observations of the house owner.
- Avoid that a single household becomes a major beneficiary of several improvements.
- Organise geographically the spreading of the different house improvements for future demonstration to other villagers (by means of organised exchange visits).

User satisfaction of the suggested house improvements is very important as it is the user that will eventually promote the house improvements to their neighbours. Therefore close attention must be given to all complaints, investigated and adjusted wherever possible.

A sample of the problems and solutions encountered are given below.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Possible Cause</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stove is too cold.</td>
<td>Clay-soil insulation works very effective but house owner wants heat radiation.</td>
<td>Do not apply the clay-soil stove in houses where large heat radiation is needed in the winter.</td>
</tr>
<tr>
<td>Stove is too cold.</td>
<td>Terracotta tiles insulate against heat radiation from the sides.</td>
<td>Remove the inside terracotta tiles for the winter period and replace in the spring.</td>
</tr>
<tr>
<td>Stove is too hot.</td>
<td>Thin metal sides of the stove and high fire needed for <em>chapatti</em> making.</td>
<td>Place terracotta tiles on the inside of the stove, thus reducing side radiation.</td>
</tr>
<tr>
<td>Stove is too hot.</td>
<td>Former method of firewood use has not been changed.</td>
<td>Try to use less firewood to obtain the best cooking results.</td>
</tr>
<tr>
<td>Front top hole is too small.</td>
<td>Owner is used to lighting the fire through the large top hole of the old <em>buchari</em>.</td>
<td>Important to explain the advantages and disadvantages of the stove to the user before the stove is bought.</td>
</tr>
</tbody>
</table>
| Chapatti top plate is too small to make many *chapatti’s* at the same time. | Owner is used to large disk *chapatti* plate. | – Important to explain the advantages and disadvantages of the stove to the user before the stove is bought.  
– Longer trapezium plate can be chosen. |
| Water in geyser does not become very hot. | Buyer assumes that the warm water construction is as good as an electric geyser. | – Important to explain the advantages and disadvantages of the stove to the user before the stove is bought.  
– Water barrel can be insulated. |
| Water in barrel starts boiling. | Barrel is too small or stove is fired too long a period during room heating. | – Larger water barrel.  
– Better insulation of the house so stove is less needed. |
| Extra firewood is used for the warm water facility function. | Inevitable. | Explain the disadvantages of the stove and water warming facility to the user before the stove is bought. |
| Terracotta tiles break. | Poor quality tile or rough treatment. | Set of replacement tiles can be bought from BACIP or from local traders. |
| Too much smoke when rings are placed. | Metal rings or lids do not close properly. | Improve the flatness and fitting of the rings. |
| Smoke with cooking pot on stove. | Surface of the stove top is not flat. | Adjust stove top by hammering it upside down on a flat surface. |
| Backdrop of smoke through chimney. | Chimney outlet is too close to the roof surface. | – Install Feri-Feri.  
– Do not use 90° bends, but rather two 135° pipe bends. |
<table>
<thead>
<tr>
<th>Problem</th>
<th>Possible Cause</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chimney draft is poor.</td>
<td>Chimney is filled with soot.</td>
<td>Take chimney out and clean with brush on a long stick, away from the house.</td>
</tr>
<tr>
<td>Roof passage of the chimney leaks water.</td>
<td>Water from roof runs into hole of the chimney roof passage.</td>
<td>Apply BACIP roof passage with plastic skirt and add soil around the roof exit.</td>
</tr>
<tr>
<td>House does not get warm.</td>
<td>Traditional open hole in the centre of the ceiling/roof.</td>
<td>Apply roof-hatch window and wall insulation.</td>
</tr>
<tr>
<td>House does not get warm.</td>
<td>Open doors and windows, poor planning of spaces.</td>
<td>Review house design and apply other BACIP thermal insulation techniques.</td>
</tr>
<tr>
<td>Baking pan does not fit into stove.</td>
<td>Opening is only 12” and door is too small for pan.</td>
<td>Obtain top-oven and learn how to use it effectively for baking.</td>
</tr>
<tr>
<td>Smoke is escaping from closure rings.</td>
<td>Pot does not fit closing ring, or closing rings are old, rusted, bent or cracked.</td>
<td>Obtain new rings and closures that are of sufficiently thick sheet metal (see text and figure below).</td>
</tr>
</tbody>
</table>

On several occasions houses were found where the "traditional" buchari was being used, but the villager complained that the house was still full of smoke. Invariably it was observed that the closing rings were not fitting properly on the stove, or a pot was not placed on the ring, or the rings were broken, bend or rusted through and not replaced with new ones. Rings and closures lids should therefore be of standard sizes (12", 8" and 6") and of sufficiently thick sheet metal to avoid bending (gauge 18 = 1.2 mm).

In our efforts to standardise the stove top and the openings, almost all villagers wanted something different in one way or another. The solving of the larger chapatti cooking top appeared to be one of the biggest problems as it required a change of behaviour. As indicated above, change in behaviour was only successful when it was accompanied with special benefits, such as less smoke or warm water.
5. ENTREPRENEUR DEVELOPMENT

During the process of developing the different designs, all articles were manufactured by the local sheet metalworkers using folding or welding techniques. The development of the local entrepreneur(s) was (and still is) a gradual process:

- In the beginning it was difficult to find a sheet metalworker that could read the sketches provided. However, after intensive guidance and comparing the sketches with the sample models, one of the stove makers began to understand the drawings.
- The entrepreneurs were not used to making a pattern (like a tailor) and were tracing the design from memory. This meant that each newly made article came out a little different. The use of the final design pattern was only accepted after some pressure and complaining that items were not exactly the same. The items needed to be identical, otherwise the rings would not fit properly on the stoves.
- It was necessary to emphasise to the entrepreneurs that the manufacturing must allow both the folding and welding methods because in many villages no welding equipment would be available.
- Some entrepreneurs could not obtain the required gauge 18 (1.2 mm) metal sheet. BACIP had bought the first supply of sheets from Rawalpindi but later organised that the local entrepreneurs would buy these from their regular supplier.
- One of the entrepreneurs worked fast, but the stoves were not straight. It was explained to him that a customer needs a good-looking, straight stove and does not want to buy a dented one or one with sharp points. At least four times he was sent back to straighten and smoothen the product.
- The planning of the optimum use of the 4 ft. x 8 ft. sheet was new for some entrepreneurs as they usually cut the pieces from leftovers, not planning efficient use of the whole sheet (see Annexes I and II).
- The making of the attachments was also done by tinsmiths (suitcase and trunk makers). It was emphasised to the stove makers, however, that a customer does not want to buy one piece here and another piece there. All articles should therefore be supplied by one shop.
- In due time the training programme would assist the sheet metalworker to pay attention to workshop lay-out, receiving and processing orders, cutting and folding in straight (good-looking) designs, reading drawings, proper finishing and packing.
- Currently orders are placed from the villagers to the BACIP office. Procedures are now being established to pass the order and down payment for the stoves directly on to the entrepreneurs. BACIP would then only provide occasional quality control of the production. The BACIP office is presently developing a quality control instruction sheet.
- Complaints from villagers about orders, delivery and other aspects are followed up by BACIP and discussed in detail with the entrepreneurs to improve customer relations and product quality. In some cases this has lead to minor improvements (for example, a better clamp or washer in the warm water facility piping as poor transport conditions caused damage and subsequent leakage).
- BACIP has been developing comparative fact sheets (in English and Urdu) on the differences between the various stoves and attachments. These fact sheets help the consumer to make the most practical selection based on his/her needs and use. A sample of the fact sheet for the stoves is presented in Annexe III.
- Entrepreneurs can place a model of his/her stove on the grounds of the BACIP office. Interested customers can then compare the different models and inspect the quality of the stoves from the various stove makers.
- New stove makers who wish to learn how to make the BACIP stoves can receive a one-day training course with an experienced stove maker at his/her own expenses\(^7\). BACIP will, however, pay for their transfer expenses.
- Plumbers or pipe fitters are making complete sets of piping and water hose connections for the installation of the BACIP warm water facility. Sets of pipes can also be sold separately and assembled in the village by a handyman.

\(^7\) For further details on the "host" training methodology, see BACIP publication entitled *Manual on Entrepreneur "Host" Training Visits* (March 2000).
Other BACIP activities include:
- Developing detailed installation manuals for local handymen (plumbers) who can then assist in assembling the warm water facility.
- Making advisory manuals on the best location to install the warm water facility for obtaining the most optimal functioning and benefit out of the equipment.
- Stimulating stove makers and plumbers to attend to the special wishes of clients directly and come up with additional solutions that can be replicated for other houses and clients.
- Co-ordinating with the Aga Khan Rural Support Programme (AKRSP) on further business enhancement training for small groups of entrepreneurs. This business enhancement training will cover such aspects as marketing, bookkeeping, personnel, workshop organisation, quality control, financing and other non-technical aspects.

The above entrepreneur development is based on:
1. Getting the hardware design in the right configuration, so it can be manufactured locally and is acceptable and desirable for the local customers.
2. Getting the software organised so the articles are well documented, order forms are made, manuals for manufacturing and installation are ready.
3. Getting the promotion organised and expanded to create demand from the villagers. This can be accomplished through a large variety of methods, including road shows\(^8\), exchange visits to houses with models, demonstrations in the office, mini-models and radio talk programmes.
4. Getting financing mobilised through AKRSP local village credit organisations and other methods.
5. Getting the ordering and delivery procedures straightened out, especially for faraway villages.
6. Monitoring quality control and the manufacturing of additional equipment.
7. Organising that one entrepreneur can deliver the entire package, including the warm water equipment.
8. Providing additional information on how to save firewood by thermal insulation and house design.
9. Providing cooking information on how to use the stove and oven to its optimal efficiency.
10. Demonstrating the best methods of marketing for the entrepreneur.

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\(^8\) See BACIP publication entitled *BACIP Road Shows – A Manual on How to Organise a Road Show* (February 2000).
ANNEXE I

SAMPLE CUTTING PATTERN FOR A COOKING STOVE

The cooking stove cutting pattern is for a 4 ft. x 8 ft. metal sheet. Clips for the terracotta lining tiles and handles for the hole covers are made from the leftover pieces.
The cutting pattern for the hole covers is for a 4 ft. x 8 ft. metal sheet. Another sheet is used for the inner-hole covers. Handles are made from the leftover pieces.
## SAMPLE OF STOVE FACT SHEET

<table>
<thead>
<tr>
<th>NAME/ TYPE BACIP CODE</th>
<th>Housing Board Buchari Medium Size</th>
<th>BACIP Metal Top Stove with Interlocking Brick Sides, Fixed Chapatti Top, One Hole</th>
<th>BACIP Stove with Metal Top + Sides, Lined with Terracotta Tiles</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PRICE</strong> GILGIT MARKET</td>
<td>Rs. 500 (without pipes)</td>
<td>Rs. 250 (without pipe, bricks)</td>
<td>Rs. 750 (without pipes, including tiles)</td>
</tr>
<tr>
<td><strong>OUTSIDE SIZE OF STOVE</strong></td>
<td>18” width (front)</td>
<td>18” to 12” width (rear)</td>
<td>18” to 6” width (rear)</td>
</tr>
<tr>
<td></td>
<td>28” length</td>
<td>32” length</td>
<td>29” length</td>
</tr>
<tr>
<td></td>
<td>6” height</td>
<td>9” height</td>
<td>8.25” height</td>
</tr>
<tr>
<td><strong>DIAMETER OF COOKING OPENINGS</strong></td>
<td>A. 16”</td>
<td>A. Closed chapatti top</td>
<td>A. 12”</td>
</tr>
<tr>
<td></td>
<td>B. 6”</td>
<td>B. 6”</td>
<td>B. 6”</td>
</tr>
<tr>
<td><strong>TYPE OF METAL</strong> (mild sheet steel)</td>
<td>22-gauge sheet or from oil/tar barrels (0.6 mm)</td>
<td>16-gauge metal sheet (1.6 mm)</td>
<td>18-gauge metal sheet (1.2 mm)</td>
</tr>
<tr>
<td><strong>CHIMNEY PIPE</strong></td>
<td>3”</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOP RING CLOSURES</strong></td>
<td>18” / 16” diam. with 8” hole</td>
<td>Fixed chapatti area in front</td>
<td>14” / 12” diameter with 8” hole</td>
</tr>
<tr>
<td></td>
<td>A. 10” / 8” diameter</td>
<td></td>
<td>A. 10” / 8” diameter</td>
</tr>
<tr>
<td></td>
<td>B. 8” diameter</td>
<td></td>
<td>B. 8” diameter</td>
</tr>
<tr>
<td><strong>POSSIBLE ATTACHMENTS NOT INCLUDED IN PRICE</strong></td>
<td>Chapatti disk 22” diameter with 16-gauge metal sheet (1.45 mm), Feri-Feri (Rs. 60).</td>
<td>Chimney air flow reduction valve. Feri-Feri (Rs. 60).</td>
<td>18” x 14” top-oven, 12” in height; fits on the front hole of stove, insulated. Ash collection tray. Feri-Feri (Rs. 60).</td>
</tr>
<tr>
<td><strong>ADVANTAGES</strong></td>
<td>Low cost. Can use large size chapatti disk 22” - 24”. Saves 20% firewood as compared with open hearth. Fast space heating due to thin sheet. Can light the fire from the top. Fits large round chapatti disk.</td>
<td>Lowest cost stove. Very suitable for outside summer kitchen. Concave fixed chapatti area. Extra thick plate, thus long life. No welding, very simple design. Long wood pieces can be used. Very low fuel wood consumption. Can be made with stone sides.</td>
<td>Long life, no welding. Can be fitted with warm water pipes. Extra large (optional) chapatti plate that fits over two holes. Terracotta tile inner lining reduces heat radiation and firewood consumption during summer.</td>
</tr>
<tr>
<td><strong>DISADVANTAGES</strong></td>
<td>Emits smoke when lighted from top. Short life and smoke leakage due to thin sheets.</td>
<td>Only one hole for cooking. Fixed concave chapatti surface is not practical for heating pots.</td>
<td>Smaller hole size than Housing Board buchari. Small chapatti plate can be used.</td>
</tr>
<tr>
<td><strong>AVAILABILITY</strong></td>
<td>All over the Northern Areas with local metalworkers.</td>
<td>Through BACIP or from metalworker shop near Jaglote Adda Road, Gilgit.</td>
<td>Through BACIP or from metalworker shop near Jaglote Adda Road, Gilgit.</td>
</tr>
</tbody>
</table>

The basic models do not have a bottom, as these are placed directly on the ground.
Prices are indicative and based on year 2000 manufacturing in Gilgit. (1 USD = Rs. 60)
ADDRESSES

Aga Khan Foundation (AKF)
12-Street 84, G-6/4
Islamabad
Pakistan
E-Mail: AKFP@akfp.org

Aga Khan Planning and Building Services, Pakistan (AKPBSP)
300/2 Garden East, Behind Ismaili Garden Jamatkhana
Karachi 74550
Pakistan
E-Mail: AKPBSP@cyber.net.pk

Aga Khan Planning and Building Services (AKPBS)
River View Road, Opposite FCNA Helicopter Chowk
Gilgit, Northern Areas
Pakistan
E-Mail: AKPBS@glt.comsats.net.pk

Building and Construction Improvement Programme (BACIP)
River View Road, Opposite FCNA Helicopter Chowk
Gilgit, Northern Areas
Pakistan
E-Mail: bacip1@glt.comsats.net.pk

For further information, contact Sjoerd Nienhuys: snienhuys@snv.org.np