CHIMNEY STOVES AND SMOKE HOODS

GETTING SMOKE OUT OF THE KITCHEN

PRACTICAL ACTION
Technology challenging poverty

technical brief

Why get rid of smoke?

Nearly half the world cooks on three-stone fires or rudimentary stoves. Indoor air pollution, caused by burning biomass fuels, such as wood and agricultural residues, causes the deaths of nearly two million people each year. The people most vulnerable are children aged five years and under, particularly infants less than six months old, and women cooking meals. Where people live a long way from towns or cities and have no choice other than to burn biomass fuels, ways must be found to burn fuels more efficiently, and to get rid of the damaging smoke from their homes. Chimney stoves and smoke hoods are two ways in which this can be done.

Methods of smoke removal

One way to get rid of the smoke is through a flue or chimney, which takes the smoke outside the house. There are basically two ways of doing this – either through a chimney stove, where the flue is an integral part of the stove (Figure 1), or using a smoke hood (Figure 2), where the hood is placed over a traditional fire or a stove, and the cook can access the stove through a front opening, allowing her to cook in a way which is familiar to her. Hot air rises up the flue out of the room.

These two systems are very different, in that the chimney stove is an enclosed system, with only a small opening to insert fuel and to let in limited air, and the flue sucks out much of the smoke out of the room. With a smoke hood, on the other hand, the fire burns largely independently of the surrounding hood – and smoke is again drawn up by the hot gases rising up the flue.

Chimney stoves

In theory, a chimney stove seems a perfect solution. With nowhere else to go, smoke vents into the open air outside the house. A well-constructed and maintained chimney stove can get rid of most of the smoke, halving the concentration of smoke left in the room.

Figure 1: A well-designed chimney stove disseminated by HELPS International in Central America. (*photo: HELPS international*)

Figure 1 shows a stove disseminated by HELPS International that fulfils all the requirements of a good chimney stove and is very popular with the user.

Such stoves can be found particularly in Central and Latin America. The top surface is a sheet of metal called a *plancha* on which tortillas can be cooked. Recesses are sometimes built into the *plancha* into which the pots can fit.

Clips at the top and bottom of the flue mean that it can be easily removed for cleaning. The opening for the fuel is exactly the right size, and there is a small bar across the opening close to the bottom to ensure that air can pass underneath the fuel so that the fuel burns completely. The material for the stove is based on a

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lightweight local tile called a *baldosa.*

What makes a good chimney stove? Table 1 indicates some of the features that are vital for a good design and some of the problems if care is not taken in design and manufacture.

Table 1: What makes a good chimney stove?

	Good design	Potential problems
Stove material	The firebox, where the burning takes place, must be made of lightweight insulating material that reflects heat back into the stove. Metal can also be used as a stove material, provided it is strong enough to last.	Despite its widespread use, mud is not a good insulator. It absorbs the heat just like a sponge absorbs water. Whilst this is happening, the fire remains cool and this causes more smoke. Metal stoves have to be protected externally as they do not appear hot, and can cause burns. They emit a lot of heat into the room, so are not good in hot regions, and often use a lot of fuel. If the gauge is not thick enough, they will distort and air will leak into them.
Chimney or flue	The chimney or flue must be cleaned every two or three weeks – so it must be easy to dismantle to make this task quick and easy. Training in cleaning of flues is a vital part of successful introduction of chimney stoves.	Flues that are fixed to the stove at the bottom and fastened firmly to the roof at the top require the cook to climb onto the roof to clean the flue. This is such a big nuisance that flues tend to be left, they block up with soot and the smoke blows back all the time into the room. The tars left behind in this instance are a fire hazard.
Flue dimensions	This is highly critical. The correct cross-sectional area and height of flue pipe will provide clean and efficient combustion. It is therefore important that the person making the stove has good design specifications and close tolerances on his / her work.	Too tall a chimney will cause too much suction on the stove and it will burn excessively quickly. The cross-sectional area needs to be sufficient to take up all the smoke, but narrow enough to accelerate the smoke out of the house.
Fuel opening size	Fuel burns best when it is cut into small pieces, and a small opening will ensure that the cook uses the right size fuel for optimum burning.	However, too small an opening may stop the cook from using the stove at all if she finds that it is a nuisance. Too large an opening allows too much air to rush into the system, cooling the fire. It will also allow the cook to use pieces of wood that are much too large. Air needs to pass under the fuel to mix with the fuel for good combustion.
Pot-holes	Ideally, these should allow the pot to sit down into the stove so that heat can reach the sides of the pot. In some Latin American countries, the hotplate is a flat metal sheet (called a *plancha)* on which food such as tortillas can be cooked directly, as in Figure 1.	Pot-holes will allow smoke out into the room unless the pot fits snugly into them. When the cook removes the pot to stir the food, smoke escapes through the holes. Also, if the stove has two pot-holes, an extra disc to block off the unused pot-hole is required, or smoke will escape. This is an extra operation for the cook.
Distance between fire and cooking pot	As the fire burns, particles of smoke are created and rise up towards the pot. In a well-insulated chamber, these particles will burn creating more heat if there is sufficient distance between the fire and the bottom of the pan.	If there is insufficient distance between the pot and the fire, the particles of smoke will move past the pot and go into the cooler flue before they are burnt. This creates more smoke and reduces efficiency.

There are many designs of chimney stove that do not work well, that create a lot more smoke than an open fire, and that burn more fuel than an open fire. As a result, large numbers of chimney stoves have been abandoned and their components used for other purposes, or they have not been replaced once worn out.

Successful chimney stoves require good design, good maintenance and good instructions on how to clean the stove very regularly. In the right place, well-designed chimney stoves can have a major impact on smoke reduction.

Smoke hoods

Another approach to venting smoke is through a smoke hood, which may be more appropriate in some situations where...

- Where people like to sit in front of a fire that they can see when they need to keep warm
- Where some kind of microfinance is available, as the smoke hood will last many years once it is installed
- Where there are metalworkers keen to broaden their skills and manufacture a new product
- Where there is not much access to other types of fuel than woodfuel and agricultural residues

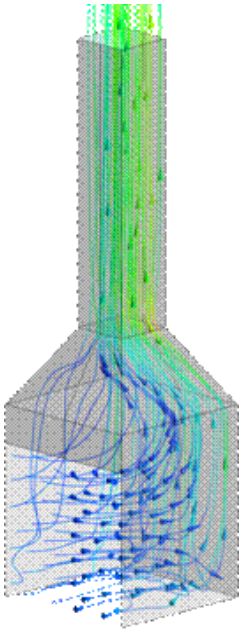

Figure 2: Computer design of smoke hood.

Smoke hoods work in a similar way to open fireplaces used for heating in many countries worldwide. They alleviate smoke by venting it out of the kitchen from the fire or stove on which the food is cooking. Practical Action has been promoting smoke hoods for several years.
Recently, Practical Action has been working with Bosch and Siemens Home Appliances (BSH) to develop a more advanced smoke hood in cooperation with the Bundeswehr Universität Department of Thermodynamics and funded via a Public Private Partnership, BSH, with a project title 'Healthy Hoods'. This has included "building" a virtual smoke hood and a fire inside a computer and step-by-step altering the various dimensions and parameters to achieve the best possible results (Figure 2). Field testing has indicated that the new design reduces indoor air pollution by over 80% - in most cases achieving WHO standards for indoor air pollution.

To make the technology as accessible as possible, the project is developing an interactive website. The website, www.healthysmokehoods.org offers anyone the opportunity to start the process of designing their own smoke hood. By providing basic data on the type of region, household size, cooking pots and habits and special needs, a customized design complete with manufacturing instructions will be generated. A film showing the impact of the hoods is available on the web: http://www.youtube.com/watch?v=y0HXGqHvbUM

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Figure 3: Using the smoke hood to brew tea - Gorkha region, Nepal.

Case study

In the Gorkha region of the Nepal High Hills where the 'Healthy Hoods' project has been undertaken (Figure 3), over 25% of the households in all of the villages have already placed down-payments. The smoke hoods are being sold without direct subsidy, and dependent upon size and location (transportation can be expensive) the hood prices range from 5600 – 6400 Nepalese Rupees (about US$65 - $75; 2012).

The project has focused on establishing local manufacturing and a financing model to allow for long-term sustainability and expansion. A revolving fund has been established whereby villagers are able to make an initial down-payment of 1000 Rupees and then finance the remainder over a 24 month period. The fund is managed by the local cooperatives which concurrently play a role in raising awareness and promotion of the technology.

Smoke hoods in other countries

Earlier work on smoke hoods by Practical Action led to very well-accepted hoods in Kenya, Nepal and Tanzania. These hoods did not remove as much smoke, but they illustrate that smoke hoods are appropriate across a wide range of cultures and types of climate.

In Kenya, the well-known low-cost *upesi* stove is built under the hood in place of the open fire, as in Figure 4. The *upesi* is a well-accepted ceramic stove which can be built into a base, with the hood set over the top to provide a neat safe environment – reducing the risk of burns and reducing the fuel costs. Another type of stove, built on a principle called a 'rocket' stove, is becoming very popular. This could be combined with a smoke hood, with the stove reducing emissions and fuel costs, and the smoke hood venting any residual smoke up the smoke hood. The smoke hood is sufficiently versatile to allow these changes to happen.

Figure 3: Woman cooking with her stove and smoke hood, Kenya. Photo credit: Practical Action East Africa

Figure 4: Maasai woman standing beside her smoke hood, Tanzania. Photo credit: Practical Action East Africa.

A successful initiative in Tanzania and Uganda involves the use of smoke hoods, combined with the installation of *upesi* stoves (Figure 5).

Some structural changes to homes included removing a wall across the door opening, and the addition of two small windows were made. The result is that the Maasai homes in this district have been transformed from enclosed smoke-filled kitchens to clean bright open houses.

The very low level of emissions now evident in the households is partly to do with the technology, but also perhaps because of the extreme fuel shortage. Women in this region walk for several hours twice or three times per week to gather fuel.

Reasons for success

Key to all of this is the *combination* of stove and hood, and the fact that the hood can be designed to fit many shapes and sizes of stove, including locally manufactured stoves that save a lot of fuel, but may not get rid of sufficient smoke to make them healthy. Putting a smoke hood on top of such a stove allows local manufacture of a stove plus hood combination that reduces pressures on forests, reducing the harmful emissions within the households, and can all be locally manufactured.

Figure 5: Manufacturing a smoke hood using hand tool in Nepal.

Smoke hood manufacture

Smoke hoods need to be made within certain tolerances, but these are not so precise as those required for chimney stoves. The hoods can be made by local artisans (Figure 6), thus providing new employment, and support if ever things go wrong.

Smoke hoods can be made in a variety of sizes; the website tool advises on the right size for a particular situation. It provides dimensions and drawings for hood manufacture. If more than one size is feasible, thought should be given to the size of hood that will minimize wastage of steel, as the dimensions should not be substantially modified once the size is chosen.

Figure 6: Detail of the metal fold at the hood intersection.

The smoke hoods currently being made in Nepal are being made only with hand tools. Steel is brought into the area as flat sheets. The sheet is then cut into several pieces and the pieces are joined by folding them tightly against each other. Some of the sections are bolted and/or riveted together. This is done by hand by skilled metalworkers who have been trained by the project team, and by one of the first entrepreneurs trained by the project.

Can people afford chimney stoves and smoke hoods?

Both chimney stoves and smoke hoods are quite expensive if you are on a very low income. However, the major problem is finding all the money at once – the *up-front* or *capital costs*. Once installed, the technologies often save fuel costs for reasons described above. One way to enable purchase of hoods and stoves is to create *revolving funds.* These funds are based on *seed capital* – an amount of money that starts off the process. A few households belonging to a community group, will buy the appliance in instalments; sometimes paying a low additional interest rate to provide a small income for the person running the fund. Once they have paid back some of the money, this provides enough funds for a few more people to get appliances. The larger the seed capital, the sooner everyone gets a chance to reduce smoke in their kitchen.

Choosing the right technology

Practical Action believes that people should have the right to choose what is best for them, and the organisation will strive to make it possible for them to purchase whatever they choose. The most important people in any development work are the people in the community with whom the organisation works.

Good chimney stoves that are well-designed and constructed will be appreciated, and therefore are more likely to be well-maintained by cooks who are keen to use them. If they are an imposed solution, they are likely to fall into disrepair.

Smoke hoods are an excellent solution if they are affordable and if people want to maintain their traditional cooking practices. They also allow people to sit in front of them when the weather is cold. The social aspects of sitting around a cosy fire should not be underestimated. All manner of stoves can be built underneath them.

Ultimately, the choice is going to be decided by the user, and by what they can afford.

References and further information

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- Good website for looking at efficient and effective stoves: http://www.crest.org/discussiongroups/resources/stoves/
- HELPS International: http://www.helpsintl.org/
- *How to Build The Improved Household Stove: A Construction Manual for the Rocket – Lorena and Shielded Fire Stove,* Ministry of Energy and Mineral Development, Uganda.
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Practical Action is a development charity with a difference. We know the simplest ideas can have the most profound, life-changing effect on poor people across the world. For over 40 years, we have been working closely with some of the world's poorest people - using simple technology to fight poverty and transform their lives for the better. We currently work in 15 countries in Africa, South Asia and Latin America.

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