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Boiling Point

Sharing information and communicating knowledge

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PRACTICAL ACTION
Technology challenging poverty

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Editorial Team

As you may have noticed, we have changed our name from ITDG to Practical Action . . . but don't worry – we are still keen to send you *Boiling Point*

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In this edition . . .

This edition moves on from the theme of scaling up to one component of it that is often overlooked during the life of a project. If we know something, how do we share it? A colleague once said that 'knowledge is power, so people often keep knowledge because giving it away makes them less powerful' – an interesting point. As the world of household energy becomes more commercialised, will it be driven solely by profit, or by sharing knowledge for the common good; can the two approaches live side by side? Somewhere the line between intellectual property rights and the common good must be drawn. We are very pleased that our authors, in this, and previous editions, have chosen to share their knowledge so that our aim to reduce poverty can be advanced through sharing this vital resource.

Contributions to Boiling Point

- **BP52: Health, safety and household energy** *Boiling Point* last looked at health in BP40, and much has happened since this edition. What have we learnt? What can we tell policy-makers when they ask how to remove smoke from millions of households in their country? What are the dangers associated with fuel-gathering, particularly in crisis situations – assault, land-mines – we need to hear from anyone taking positive action to reduce these risks. Safety of children – what can be done to reduce the number of burns for children – and also women? If you can share your knowledge, this is a vitally important issue.
- **BP53: Technologies that really work** In the last five years, many effective new technologies have been developed. This edition is the first for some time that is unashamedly technology-oriented. We would like to include a wide range of proven technologies. Ideally, they should have been used in households successfully for at least several months/years, and also tested to ensure that they do what they are intended to do – reducing fuel use, reducing smoke, costing less etc. What sort of technologies? – stoves (all fuel types – that both reduce fuel consumption and smoke); lighting – using electricity, kerosene, solar, LPG; heating stoves; institutional stoves; stoves for cooking/heating in emergency situations; other cooking technologies – such as hot boxes. Ideally, each article to include: a good description; how and where it has been tested; the cost of the technology; the level of complexity for construction and maintenance; a couple of photographs; information on where people can get more details – drawings, support, further information, and permission to use the design; please include non-web ways of accessing technical drawings (if at all possible).

We're on the Practical Action website too www.practicalaction.org/boilingpoint.The good news is that the journal is visited by around 200 people per month, with over a third to a half of those people downloading articles, in addition to the 2000 copies which we send out each edition.

Articles should be no more than 1500 words in length. Illustrations, such as drawings, photographs, graphs and bar charts, are essential. Articles can be submitted as typeseripts, on disc, or by email.

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Cover photo: 'Smoke is bad for you' – theatre group in Kisumu, Kenya (photo Practical Action – East Africa)

High altitude smokeless metal stove research and development

Kanchan Rai, A. Zahnd and J.K.Cannell, Kathmandu University, Dhulikhel, Nepal

Introduction

A Jumla-designed 'smokeless' metal stove, manufactured and distributed from 1995, is used by some 2783 families in the villages in Jumla, Mugu and Jumla, in the Karnali zone. Now a stove project, researching secondary combustion, has been introduced at Kathmandu University (KU), based on experience gained from the Jumla-design stove.

Data on firewood *(daura)* use

Firewood accounts for 80% of energy consumption in Nepal, with 90%–100% dependence on firewood in rural mountain areas. According to a survey carried out in 1999 in the remote Jumla VDC of Patrasi and Gothichauer, mountain communities use up to 3000 kg per person (18000 kg per family) of firewood per year, comprising 32% for cooking and 56% for heating, compared with 40% for cooking and 36% for heating in lower hill areas. The remainder is used for lighting, boiling water and agro-processing activities. In Jumla, every home in the remote and high altitude villages uses firewood in open fireplaces for cooking, heating and lighting. In winter, families consume 30 kg–50 kg of firewood per day, using most of the firewood for space heating and cooking.

Rural development data

Kathmandu University's Research Development and Consultancy (KURDC) Unit, sponsored by the ISIS Foundation of Bermuda, has developed a rural energy service development programme for Jumla people. During 2003–2004 a detailed survey of household wealth in the two villages of Chauganphaya (63 houses) and Kholsi (56 houses) measured:

- 95% of the houses are build with stone/mud, 5% with stone/dry masonry
- 94% of households use an open fire and an *odhan* (one-pot tripod) for cooking, 3% use an open fire with stone supports, and 3% use a non-Jumla designed enclosed stove.
- For heating, 97% use open fire, 1 household uses a non-Jumla designed enclosed stove.
- For lighting: 97% use *jharro* (a resin soaked pine wood stick from the local available pine tree called *salla*. One household uses a small Chinese solar PV home system.

Health and environment

> Women and children are most likely to suffer from the enormous indoor smoke pollution problem, causing respiratory diseases and other serious ailments. Nepal is one of the very few countries in the world with a lower female life expectancy rate than men. The constant deforestation means that people, mainly women and children, spend up to seven hours every second day gathering fuel wood.

High altitude smokeless metal stoves

Jumla Design Stove (original design)

Mr. Alex Zahnd worked for 5 years with the United Mission to Nepal as the Jumla Rural Development Project Director where he developed the *Jumla Design* stove. Properly used, the stove consumes forty percent less firewood than a traditional open fireplace cooking fire, and also produces nine litres of hot water in a side water vessel. Currently, the stove is installed with a fifty percent (NRp 2500) subsidy to farmers in Jumla; the remainder is raised through project donors. The stoves are manufactured in Nepalgunj, and up to June 2005 a total of 2783 Jumla Design Smokeless Stoves have been installed in the Karnali zone.

This stove is especially designed for use in high altitude areas. It has a flue and three pot holes, enabling an entire traditional meal Dal Bhat (rice, lentil and a vegetable dish) to be cooked at the same time. The attached water vessel provides continuously hot water. A Roti Grilling Device included, allowing roti to be baked in the traditional way directly on the embers. The stove has a mud-filled double bottom for insulation. Air draughts are regulated through an adjustable valve in the main door, and a damper in the flue pipe. Walls are 1.5mm steel, and the upper cooking surface is 4 mm, with 4 mm reinforcing rings. These stoves are portable, and have 'worn' well in daily use.

Figure 1 Jumla family with no light and with no cooking stove (*photo: Kanchan Rai*)

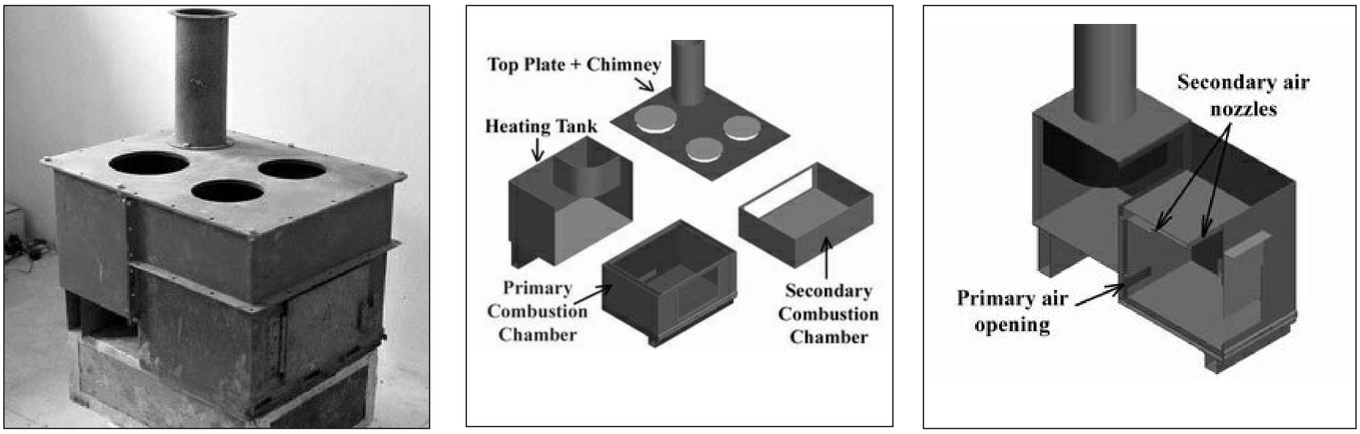
KU-2 (new design)

In 2001–2002, two students of KU Mechanical Engineering Department engaged in a Smokeless Metal Stove project to develop a stove, with secondary combustion, that is at least twice as efficient than the 'Jumla design' stove. With the sponsorship of SINTEF, Norway, a new prototype KU-2 has been designed and tested.

In the KU-2 stove, firewood is loaded through the main door into the primary combustion chamber. The

Figure 2 Jumla family with a 'Jumla Design' stove (*photo: Kanchan Rai*)

R & D



(a) (b) (c)

Figure 3 (a) Improved stove; (b) improved stove schematic; (c) secondary combustion chamber detail

floor has a grate for air passage into the primary combustion zone. The tray for ash serves as an air passage for both primary and secondary chambers. Separate vents for each air passage control the airflows. There is a water tank made of stainless steel, holding eight litres of drinkable water and a 'Roti Grill'. In the secondary combustion chamber, hot air from the secondary air passage is mixed with unburned flue gases from the primary combustion chamber to promote further combustion of flue gases, reduce energy losses and increase the efficiency of the stove. After combustion, the cleaner exhaust gases escape through the chimney, which has an adjustable damper to control the draught.

The primary air flowing below the floor is preheated, and the secondary air supply beneath the primary zone floor and up the back of the primary chamber enters the secondary combustion chamber through two layers of nozzles, well preheated. Both secondary and primary chambers are insulated using mud. A baffle plate below the chimney induces better circulation of hot flue gases, making maximum use of convective heat transfer. Air flows are controlled by a primary air sliding vent, two secondary sliding air vents and a damper in the exhaust pipe.

Table 1 Results

Fuel consumption	With the KU-2 stove the firewood consumption is slower and thus the same amount of wood burns for much longer than in the 'Jumla Design' stove
Heat transfer	The KU-2 stove transfers the combustion energy (by radiation and convection) to the cooking utensils better, and over a longer period, than the 'Jumla Design' stove.
Chimney temperatures	A chimney temperature of around 400°C occurs in the 'Jumla Design' stove, and this is higher than that occurring in the KU-2 stove. The very hot flue gases escaping in the original stove result in a lower stove efficiency.
Velocity	The velocity in the 'Jumla Design' stove chimney is about 1.4 m/s for the first 10 minutes and then drops slowly. Since the KU-2 stove burns firewood more slowly, its velocity is also lower.
Combustion chamber temperatures	The primary chamber temperature is around 600°C in the Jumla design stove, with maximum values of up to 700°C for a short time. The second chamber temperature is lower for the first half of the test period and then reaches about the same level during the remainder. In the KU-2, the primary combustion chamber is the hottest zone, measuring 600 to 750°C. Ideally the secondary zone should have higher temperatures than the primary, but with the present KU-2 design the secondary air usually is not quite hot enough to ignite and a redesign is needed.

Results

See Table 1.

Conclusions

The secondary combustion stove is still in the design, research and testing phase, though already it has been shown that increased available energy for cooking and heating can be achieved with the same energy input.

Further changes are planned to: the chimney position; secondary air passages; airtight seals; improved energy loss measures; and a glass door (because users insist on keeping the door open so as to see the flames).

Already this stove demonstrates the potential of improved domestic metal stoves for use at high altitudes. Continued design, research and development will allow us to build on our understanding of the processes involved, step by step, until we have developed a truly effective product.

References

Alex Zahnd: Murdoch University (Western Australia) thesis for MSc in Renewable Energy, 2004

Kanchan Rai completed his Mechanical Engineering degree from Kathmandu University in 2002. He has worked as a Research Assistant at the Research, Development and Consultancy Unit in Kathmandu University. His project was entitled "Development of an Improved Cooking Stove for Mountain Areas of Nepal". Kanchan is now doing an MSc on Energy and Environmental Technology in Telemark University in Norway.