CLEAN COMBUSTION

Replacing the traditional 'chulha'

A handful of innovators is looking for ways to make the stove safer, and more environment friendly

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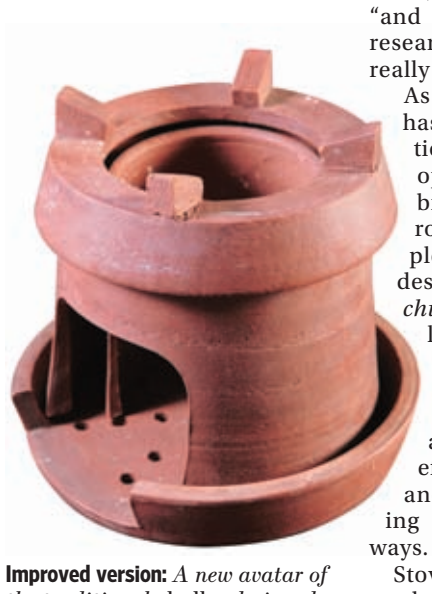
PUDUCHERRY

Even discounting south India's routine humidity, the headquarters of Prakti Design Lab is a sweaty place. At every turn, water-filled pots seethe atop wood or charcoal stoves, throwing knots of steam into the air. These pots come in varying sizes; some hold just enough water to make three cups of tea, others can boil rice sufficient to feed 150 people.

Watching over these stoves with a stopwatch in his hand is, quite often, Mouhsine Serrar, an animated Moroccan who has been living and working in Puducherry for nearly five years. In 2007, Serrar founded Prakti, one of the few dedicated stove research firms in the world—so few, in fact, that "last year, for some reason, we had 10 or 11 full-time staff", Serrar says with a laugh, "and we became the biggest research firm in the world. It really doesn't take much".



Improved version: *A new avatar of the traditional* chulha *designed by Prakti.*

As tiny as this industry is, it has one enormous ambition: To replace the developing world's traditional biomass stoves, used by roughly three billion people across the planet. The design of the basic mud *chulhas* found in Indian villages—and their variants elsewhere in Asia, Africa and South America—has persisted, with all its thermodynamic inefficiencies, for decades, and this constancy is proving destructive in multiple ways.

Stove experts such as Serrar tend to mention the suffering environment first. Every day, these stoves' three billion users burn 1kg of biomass apiece, releasing a total of 6 billion kg of carbon dioxide—three times that released by all the private cars in the US daily, and thus a generous contributor to global warming.

But the stove can injure its user's health as much as the planet's. In a February 2008 paper, Esther Duflo and Michael Greenstone, of the Massachusetts Institute of Technology's Poverty Action Lab, noted that "women and children who congregate near cooking stoves are exposed to pollution levels unheard of in the developed world". This pollution consists of carbon monoxide, but also of minuscule particles of soot that can ignite virulent cases of lung disease.

In India, in the hot dome of space around a *chulha*, particulate matter concentrations can touch 20,000 micrograms per cu. m; the recommended limit is a mere 50. "For some of these women," Serrar says, "it's like smoking several packets of cigarettes a day." Last year, a study published in *The Lancet* estimated that indoor air pollution—the exhalations of *chulhas*—causes 400,000 premature deaths every year in India.

This lethal double blow, to the environment and to public health, has suddenly elevated the profile of the humble stove. Last December, the ministry of new and renewable energy started a National Biomass Cookstove Initiative (NBCI), although little of note has progressed since. Two months ago, Hillary Clinton, the US secretary of state, launched a Global Alliance for Clean Cookstoves, which plans to install 100 million clean stoves around the world.

Creative spark: *Govindammal of Anpakkam, Tamil Nadu, (top) uses a Prakti stove; (above) Prakti CEO Mouhsine Serrar (right) and others participate in a design-review meeting for the next generation of stoves.*

But the economics of this crusade don't escape any of its participants. Crude village *chulhas* are popular precisely because they can be cobbled together for as little as ₹50, and because firewood and cow dung, though painstaking to collect, are readily available. "We're competing with *chulhas* that cost next to nothing," Serrar says. "It's a big market out there, true, but it's very risky. You have to be either stupid or crazy to do stoves."

A question of design...

Serrar doesn't specify precisely which of those qualities led him, in 2003, to quit his job as a mechanical engineer in California and join Aprovecho Research Center, a non-profit stove lab that is the spiritual grandfather of every other research firm. After studying stoves at Aprovecho and working on projects in West Africa, Serrar arrived in India in 2005 to head up stove development under a Shell Foundation grant; he started Prakti, on his own dime, two years later.

Prakti's facility is spread over a small, wooded plot of land. One large, jellybean-shaped room serves as an office space, while another room, a short walk away, is a functional workshop. The workshop is now dominated by a spectacular piece of apparatus, consisting of a large gas hood leading to a long tube that resembles the barrel of a bazooka.

"That's a piece of equipment to measure the emissions from a stove," Serrar says. Nodding to Candida Crasto, a new Prakti employee, he goes on: "Candida was coming here from the US, and she asked if I wanted anything from there. I told her this was the only thing I wanted."

"That's true," Crasto laughs. "You did."

The human race has been burning wood for so many centuries that it is tempting to think of combustion as a simple, easily perfected process. Rajendra Prasad, a professor at the Indian Institute of Technology, Delhi (IIT-D) and a doyen of stove design, is even

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willing to identify a single key principle in combustion: "It's chiefly a question of air flow." The challenge—as yet unmet, Prasad says—is to craft a better stove without making it prohibitively expensive for the people who are its main users.

Most traditional stoves are unable to allow in the precise volume of air to be efficient. Too little air produces thick smoke; too much air cools the flames. Their mud bodies can be awful insulators, haemorrhaging precious heat. These stoves thus devour far more fuel than necessary, and they are prodigious smoke producers to boot. They often don't have chimneys, and when they do, Serrar says, "the outlet is constricted. If there's a chimney, and if there's still smoke in the room, somebody has screwed up somewhere".

The effects of such stoves have transformed Govindammal's home, a hut in the village of Aanpakkam, near Puducherry. Her kitchen is a long, narrow space at the back of the house, and the mud stove she used till recently blackened the roof's rafters and the wall on which a poster of Sivaji Ganesan is pasted. Every evening, when Govindammal started making dinner, her husband Koneri says, "we couldn't stop coughing, because smoke would pour even into every room. The children couldn't study—the smoke was that thick".

The Prakti stove that Govindammal bought in February—one of around 7,000 that Prakti has sold since it went to market late last year—is a blue two-pot model named Leo. Its mantle of sooty tarnish shows how avidly it has been used. The stove cost Govindammal ₹1,500—as compared with ₹1,000 for a single-pot model—and she bought it out of her savings in a local self-help group. "I'd need five or six bundles of firewood a day with the old stove, which I'd collect on my way home from the fields," Govindammal says. "Now I need two, maybe three bundles."

On parameters of efficiency, the Leo—the newest of the seven stove models Prakti has developed over the years—is promising. It halves the use of wood, and it reduces carbon monoxide emissions by 80% and particulate matter by 40%. Prakti's other stoves perform similarly well; 600 units of its biggest model have recently been purchased by the United Nations for use in Haiti, so brutally deforested a country that savings on wood go further there than elsewhere.

But the Leo's stainless steel frame, its cast-iron grate, and its insulation of autoclave aerated cement come at a price. Manufacturing the stove costs roughly ₹2,500-3,000 per unit, and its price tag of ₹1,500, though loss-making, is still too high for most customers. "We're learning that there's a ceiling for stoves—around ₹1,000," Serrar says. "The thing is, in villages, the man of the household doesn't make the decision about a stove—the woman does. And the woman can't take a decision to spend that much on a stove."

...and a question of price

Other stove firms have also run into intractable price issues. Envirofit India, a Bangalore-based company, was set up in 2008 by Envirofit International, an international non-profit. The firm started out selling a basic model—looking very much like a black bucket with a hearth cut into it—for ₹500, but P. Ravi Kumar, Envirofit's operations manager, says: "That wasn't a sustainable price."

That base model now costs ₹899; a deluxe version, painted a vivid Cheetos orange, costs ₹1,499. The prices are difficult to drag down, in part, because Envirofit has its stoves designed in Colorado and made in China. Kumar insists this is unavoidable. "We use an alloy of chromium, aluminium and titanium, and we couldn't find an alloy manufacturer here," he says. "Then, we use a particular refractory material, but again, we could find that in China but not India."

Envirofit now sells 8,500 stoves a month in the four southern states and Maharashtra. It sounds a respectable number, but Atul Joshi, senior manager for sales and marketing, estimates that they'd need to sell a monthly 25,000 to start breaking even.

Part of Envirofit's new strategy to hit that target involves ceasing to sell through NGOs and self-help groups—as Serrar still does—and moving away from the hoary rural marketing ideas they started with. "If we'd continued selling from vans and doing road shows and street plays," Joshi says, "my next two generations would've continued to struggle to build numbers."

For both Envirofit and Prakti, the richest mother-lode would be struck if their designs found favour with the NBCI, which could afford to somewhat subsidize the cost of these stoves and buy them in muscular numbers. But the NBCI hasn't yet decided how to price the stoves it will eventually distribute, says Prasad, who is a member of the project team.

From 1983 to 1989, Prasad worked on another government stove campaign, and he has seen the disadvantages of giving away stoves for free or close to free. "The stove came with a cement pipe to be used as a chimney," he recalls. "So people would come to get our free stoves just for the pipe, which they could then use as drainage pipes or for other purposes." That project ran until 2003, when it was shut down—because, Prasad says cryptically, "of poor feedback."

That previous project distributed 34 million stoves over its 20 years, either building them in situ with mud or, later, handing out spare iron frames on which a pot could rest. Results, Prasad admits, were mixed. "The emphasis at the time was on reducing wood consumption," he says. "It's only now that we're focusing on clean combustion. Also, if you get a measure of how many of those stoves survived...well, for 34 million stoves, let's just say that the impact it could have made was not there."

The NBCI, Prasad says, will be design-neutral: It will test as many stove designs as possible and pick the best, irrespective of whether that has been designed by a company, a non-profit, or a government agency. But Prasad's own thoughts are revealing. "I think there's still a lot to be learned from the *chulha*," he says. "We should be improving upon it, not necessarily building something entirely new."

Serrar agrees with Prasad; in fact, a part of Prakti's work involves teaching artisans how to build wiser *chulhas*. "But you need the scientists. Sending bureaucrats and consultants to do this is like asking a butcher to design a wedding dress," Serrar says. "Designing a stove is hot, dirty work, and you need the geeks sitting in the labs, who are willing to get the wood, get down on their knees, and feed a fire. That's what you need."

Checks and balances: 1. *Prakti's Candida Crasto operates a portable emission testing system.* **2.** *A Prakti employee runs a test to determine the durability of a stove.* **3.** *A chamber to check stove quality at Envirofit in Bangalore.* **4.** *A lab for testing stove emissions at Envirofit.*

Photographs by Hemant Mishra/Mint

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VIDEO

Designing cheap wood and charcoal stoves to replace the traditional mud 'chulha'.

www.livemint.com/stoves.htm