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Cooking Practices and Cookstoves Field Insights:

A Pilot Study of User Experience with Traditional and Improved Cookstoves

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Keywords

Cookstove, cooking practices, fuel, energy, improved cookstove, community, subsidy, NGO, LPG, design principle

Abstract

Traditional cookstoves are used extensively across rural households in India. The use of traditional cookstoves corresponds directly to the free access and easy availability of cooking fuels such as firewood, cow dung, leaves, twigs etc. The development community across the globe comprising of governments, NGOs, civil societies and individual companies have been designing improved cookstoves to help reduce the pressure on forest resources, reduce the time spent collecting cooking fuel, decrease families' exposure to indoor air pollution and reduce climate forcing emissions. Despite all the concerted efforts across the public, private, and NGO sectors, improved cookstoves have not seen widespread adoption across rural India, the reasons for this non-adoption being multifold.

This paper is the result of a field research undertaken across five states in India over a period of two months. The first part of the study aims to develop an understanding of traditional cooking practices with regard to fuel and cooking technology. It also aims to capture the social and cultural activities that take place before, during, and after cooking across India. The second part of the study looks at some of the improved cookstoves currently in the market and assesses the user experience surrounding the use of these improved cookstoves. The findings of the study will be helpful in understanding the household level dynamics of cooking which can lead to designing stoves with more acceptability.

Introduction

Over the past three decades, the development community across the world has been designing improved cookstoves and making them more accessible for the rural masses. Improved cookstoves help to reduce the pressure on forest resources, reduce the time spent collecting cooking fuel, decrease families' exposure to indoor air pollution, and, more recently, reduce climate forcing emissions. Early improved cookstove initiatives were spearheaded by the government, the international donor community, and non-governmental organizations. Despite concerted efforts across the public, private, and NGO sectors, improved cookstoves have not seen widespread adoption across rural India. Factors that have hindered improved cookstove initiatives from reaching scale include, but are not limited to, poverty, poor design and/or marketing leading to a perceived lack of value for money on the part of consumers who could pay and business strategy challenges including the facts that distribution, sales, customer education, and marketing in rural areas are time and resource intensive as well as risky. The poverty debate till date has talked about the ability to pay; however, of late the focus is shifting towards the willingness to pay for the cookstoves. The consumers need to see the perceived benefits of the cookstove in order to increase demand for it, while at the same time the product needs to be invisibly designed¹ so that it is user friendly. More attention needs to be given to the questions of what would improve household perceptions of value-for-money of improved cookstoves relative to existing practices and non-renewable alternatives such as LPG as well as what are business strategies for disseminating stoves.

This paper is a first step toward understanding household perceptions of value for money in improved cookstoves. In keeping with general practice in marketing, the study seeks to gain an understanding of the underlying activity for which stoves could provide value – cooking; and the socio-cultural activities that surround the act of cooking. It documents the results of a small pilot study to: 1) profile the cooking practices across rural India highlighting the similarities across states while simultaneously taking note of the possible differences, and 2) examine user

¹ In context of the study: Designed in a manner that the new cookstove is close to the traditionally used cookstove in terms of usage and operation, however in terms of efficiency the new cookstove is more efficient.

experience with some of the leading cookstoves in the market. Given the time constraints, the sample size of the present study was kept relatively small in order to test the survey instruments and protocols while at the same time collecting insights that could be used to fine-tune and motivate more in-depth research.

CDF's goal is to generate a series of actionable design and implementation principles to ensure the next generation of improved cookstoves is appealing to rural households, meets their cooking demands, and delivers health, economic, and environmental co-benefits.

Traditional Cooking Practices

Methodology:

In this part of the study, field research was undertaken to understand traditional cooking practices in order to gain deeper insight into fuel and cooking technology preferences of end users across India. In addition to user preferences and habits related to the physical act of cooking, the study also aimed to capture social and cultural activities that take place before, along with, and after cooking. These include, but are not limited to fuel collection, fuel preparation, food preparation, child care or other activities during the cooking process, as well as stove maintenance and cleaning. The research team used observational research indicators, semi-structured interviews, and focus group discussions to filter information from the field.

Despite overall similarities across cooking practices, different regions in the country exhibit possible subtle variations in the staple diet (such as variations in consumption patterns of rice and *rotis*, frequency of cooking vegetarian dishes over non-vegetarian etc).² This may have important implications for the design and ultimate success of improved cookstoves. Table 1 below, based on findings from our field research, presents a matrix of cooking segments with fuel usage patterns across different varieties of traditional stoves. The table shows primary and secondary fuels used across India. This fuel pattern is decided primarily by the availability of a

² Some variations are mainly owing to the cropping patterns in the regions. The rice belts of India have rice as the major starch, where as the wheat producing regions have a preference for roti.

particular type of fuel in a region, however it also depends on factors such as what fuel gives the maximum efficiency when used in a particular type of stove or which fuel is better suited to cook non-vegetarian/vegetarian food.³

Table 1: Cooking segment matrix

Stove/Fuel	Vegetarian	Non-vegetarian
3 Stone/Brick Chulha		
Wood	Primary	Primary
Wood Chips	Primary	Primary
Twigs/Leaves	Secondary	Secondary
Coconut Husk/Casuarina	Coastal areas	Coastal areas
Crop residue	--	--
Coal	--	--
Dung Cakes	Secondary	Secondary
Mud/Clay Chulha		
Wood	Primary	Primary
Wood Chips	Primary	Primary
Twigs/Leaves	Secondary	Secondary
Coconut Husk/Casuarina	Coastal areas	Coastal areas
Crop residue	--	--
Coal	--	--
Dung Cakes	Secondary	Secondary
Tin can Chulha		
Wood	--	--
Wood Chips	Secondary	Secondary
Twigs/Leaves	--	--
Coconut Husk/Casurina	--	--
Crop residue ⁴	Primary	Primary
Coal	--	--
Dung Cakes	--	--

³ CDF is also undertaking analysis of NSSO data on household fuel use across India.

⁴ Chaff from crops like wheat, *jowar* and *bajra* were used in study households in Maharashtra. Corn cob was used in study households in Madhya Pradesh.

This study was conducted in a total of ten villages in five states across India. In order to ensure variety among the study villages, this study employed quota sampling⁵ to identify and divide sub-groups on the basis of their cooking practices and fuel use across the country. Within the states a non-random selection was employed to select districts and villages. The districts were selected on the basis of maximum diversity in terms of availability of crops/coastal proximity/economic condition. One to two districts were chosen from each state, with two villages selected as the study sites. To identify participant households (representing different socio-economic status, cooking practices and fuel usage) within each village, the study used judgmental sampling⁶, informed by a village transect walk. Keeping in mind the timeline for this pilot study, villages were selected to suit the above-mentioned criteria with the help of local partners to facilitate the work.

Regions such as Orissa and Maharashtra have coastal areas which are diverse on the basis of the average earning capacity of the households, while Madhya Pradesh has the largest forest cover in the country with a number of legal restrictions imposed on the collection of firewood for cooking purposes. Tamil Nadu has the best-connected rural areas in the country which make LPG more readily accessible to the rural households and thus a realistic competitor to improved cookstoves using renewable fuels. Table 2 below provides a snap shot of cookstove usage in the regions and households profiled.

⁵ A sampling method of gathering representative data from a sub-group with an effort to ensure a certain distribution of demographic variables such as socio-economic status, caste and community groups

⁶ In context to this study: A sampling technique based on a researchers decision as to which households will be suitable for the study given the limited time to conduct the study

Table 2: List of households profiled and cookstove usage

State Name	Household No.	Hamlet	Village	Block	District	LPG	Traditional cooks stove	Improved Cook stove	Kerosene Cook stove
Uttar Pradesh	HH 1	**	Lakhnipur	Jagdishpur	Sultanpur	N	Y	**	**
Uttar Pradesh	HH2	**	Lakhnipur	Jagdishpur	Sultanpur	N	Y	**	**
Uttar Pradesh	FGD (5 HHs)	**	Khairatpur	Jagdishpur	Sultanpur	3/5 HHs	5 Y	Y	5Y
Orissa	HH1	New Buxipalli	Buxipalli	Rangeilunda	Ganjam	N	Y	**	**
Orissa	HH2	New Buxipalli	Buxipalli	Rangeilunda	Ganjam	N	Y	**	Y
Orissa	HH3	Eplisahi	Buxipalli	Rangeilunda	Ganjam	N	Y	**	**
Orissa	HH4	Kanheiput	Tamna	Kukudakhandia	Ganjam	N	N	Y	**
Orissa	HH5	Ramapalli	Tamna	Kukudakhandia	Ganjam	N	N	Y	**
Maharashtra	HH1	**	Kapashi	Phaltan	Satara	Y	Y	**	Y
Maharashtra	HH2	**	Kapashi	Phaltan	Satara	Y	N	Y	Y
Maharashtra	HH3	**	Kapashi	Phaltan	Satara	Y	Y	**	Y
Maharashtra	HH4	**	Kihim	Alibaug	Raigarh	N	Y	**	Y
Maharashtra	HH5	**	Kihim	Alibaug	Raigarh	Y	Y	**	Y
Madhya Pradesh	HH1	**	Pippalia Goli	Obaidullaganj	Raisen	N	Y	**	Y
Madhya Pradesh	HH2	**	Pippalia Goli	Obaidullaganj	Raisen	N	Y	**	N
Madhya Pradesh	HH3	**	Chainpura	Narsingharh	Rajgarh	Y	Y	**	Y
Madhya Pradesh	HH4	**	Chainpura	Narsingharh	Rajgarh	N	Y	**	N
Tamil Nadu	HH1	**	Vilathikulam	Vilathikulam	Thoothukudi	Y	Y	**	Y
Tamil Nadu	HH2	**	Subramaniyapuram	Vilathikulam	Thoothukudi	N	Y	**	Y
Tamil Nadu	HH3	**	Subramaniyapuram	Vilathikulam	Thoothukudi	N	Y	**	Y
Tamil Nadu	HH4	**	Subramaniyapuram	Vilathikulam	Thoothukudi	N	Y	**	N
Total No. of States: 5	Total No. of Households: 25		Total No. of Villages: 10	Total No. of Blocks: 8	Total No. of Districts: 7	LPG in 9/25 HHs	Traditional Stove in 23/25 HHs	Improved Cook stove in 9/25 HHs	Kerosene Cook stove in 16/25 HHs

Existing cookstoves:

The existing stoves that were being used in the study households across the five states can be broadly divided into three types:

- LPG two-burner cookstoves
- Kerosene stoves
- Traditional cookstoves (*chulhas*)

Traditional clay cookstoves can be divided into fixed and non-fixed cookstoves. The fixed cookstove, either home-made or bought from a potter/local market place, is placed on the ground or on a raised counter platform approximately 2.5 feet above ground level (this counter platform was only observed in Tamil Nadu) and fixed with clay plaster. The numbers of burners vary – generally one, two or three. The non-fixed stove is generally a one burner stove, either domestically made or bought from a potter/ local market place. It was observed that there were no significant ritual designs around the cookstove in the study households across states. The only exception was that of a fisherman’s household in a coastal village in Orissa, where designs were drawn around the stove during festivities.

Some place-specific modifications were observed. In a tribal village in Madhya Pradesh in one of the households, the area surrounding the cookstove was elevated about 1 inch with clay plaster and in another household there was a clay 1 inch elevated border surrounding the fireplace to collect the ash and prevent it from spreading out. It was observed that in the study villages in Tamil Nadu, the traditional clay stoves had a provision for a chimney (made out of clay) which let out the smoke from the cooking area outside the house. This chimney was an innovation of the traditional practice of making a clay cookstove (made domestically or by a local potter) and not a result of any intervention by an organization or by a government program.

Traditional brick cookstoves are basically a stack of bricks placed one above the other to form a sort of enclosure to burn the fire and sometimes layered with clay to hold bricks in place.

The brick cookstove was an easy alternative to the clay cookstove for Leela, a respondent in Kihim Village in Raigarh district in Maharashtra owing to her husband’s frequent practice of getting drunk, entering into a quarrel with her and breaking the clay stove.

Traditional Husk/ chaff/ bran stoves are made domestically from empty 20 liter oil tin cans with a cylindrical pipe placed in the middle. The area around the pipe is filled with husk/ chaff/ bran from crop harvest (such as wheat, *jowar*, *bajra*). It has a small cut out at the bottom to insert a piece of burning firewood to ignite the husk/chaff/ bran. The fire burns evenly for approximately two to three hours in a fully filled can, producing heat without having to tend it. It is mostly used for heating water for bathing or boiling water for drinking and rarely for cooking. However this stove was used in a household in Maharashtra to roast *bhakris*.⁷

Several stoves being used at the same time:

Most households studied used a combination of cookstoves. Though the traditional clay/ brick cookstove remained the primary cookstove for cooking the major meals of the day, other cookstoves including kerosene, LPG and husk/chaff/bran cookstoves were used as secondary stoves. Kerosene stoves were used sparingly in households as most households use kerosene procured

Most of the households profiled during the study use multiple stoves for cooking. The only exception were a few tribal households in Madhya Pradesh and Orissa, who could not afford multiple stoves and were still using the traditional home made stove for cooking.

from ration shops under the government's Public Distribution System to use in the stove. The limit on kerosene procured through the ration card is 3 liters/month for BPL households and 2 liters/month for non-BPL households at Rs.10 per liter. The amount of kerosene sanctioned and the cost is similar across all states. None of the households profiled in the study bought extra kerosene as this meant buying kerosene at the market price which ranges between Rs.24 to Rs. 40 across various states and thereby increased the cost of cooking (and lighting).

9 out of the 25 households studied had an LPG connection. The LPG stoves were used for making tea as well as for making quick snacks or breakfast. These were also used at times when there were guests at home and there was not enough time to light the firewood in the traditional cookstove. The average cost of an LPG cylinder across states ranges from Rs. 250-330 (depending on state subsidies), and one cylinder lasts for almost 2 months if it is used regularly

⁷ A type of *roti* specific to Maharashtra which is made with hand from flour of different grains such as wheat/ *bajra*/ *jowar* and rice

to cook complete meals for about 5 people in the household. Since LPG is not accessible and affordable for all households in different regions, its usage remains limited.

Cooking patterns:

The general pattern across states was cooking two main meals during the day, once in the morning and later in the evening. Tea was also made twice a day, on LPG cookstoves in households with a LPG cookstove and on the *chulha* in households without LPG cookstoves. Cooking breakfast separately was not a common practice in the villages across states, except in households with children (for whom breakfast may be cooked) or in the wealthier households. The average amount of time spent in cooking a meal ranges from one hour to two hours, depending on the family size.

Once the cookstove is ready for use⁸ firewood is fed into the stove and a little kerosene is sprinkled on the firewood (especially if the firewood is wet from rain). Dry leaves or dry grass is ignited with a matchstick and set on the firewood. Also, bits of dried cow dung cakes are used to ignite the fire since it burns easier as compared to firewood. Cow dung, however, was not a primary source of fuel used in the study households as it burns faster than firewood and produces substantially greater amount of smoke when compared to firewood. Hence, was used as a complementary fuel. The usual cooking process begins with boiling the water to cook rice and *dal*. As the *dal* and rice get cooked, other preparations such as cutting the vegetables, gathering the spices and grinding the *masala* are carried out. Once the *dal* and rice are cooked, the vegetable/ curry is cooked and meanwhile the dough for making *rotis* is kneaded. Finally the *rotis* are made. This was the general sequence of activities followed across the study households across the five states. The cooking practices varied only up to the extent of variation in the availability of food items across the different regions. For example, in Maharashtra, in the coastal area of Raigarh district, coconut milk or coconut powder is added to vegetables/ curry for a distinct flavour, while in the non-coastal area of Satara district, groundnuts are used instead. Also, it was observed that there are few flavouring (spices/ masala) differences in the way *dal*

⁸ After cleaning and layering the stove, the frequency varying from once a day to once a week and the process of which is described below in this document

vegetables/ meat/ fish are cooked across regions. As the cooking process comes to an end, no more fuel was added to the fire. Also, the fire is not tended any further. The fire starts extinguishing by itself. At times, when the flame is very strong and the fire doesn't seem to be extinguishing soon, a small amount of water is sprinkled on the burning firewood to extinguish the fire. Another way of putting off the fire is to bury the burning log of firewood into the ash or mud. Extinguishing the fire ensures that the firewood is not burning after the cooking is over and can be reused. Households which face difficulty with access to firewood or are paying for firewood are more particular about unnecessary burning of the firewood. There is no region specific pattern that emerges with regard to the way in which the fire is extinguished, rather, it seems to be a matter of habit. In some cases, the semi-burnt / charred firewood was used as charcoal. Some of the study households across states sold this charcoal in the market at the rate of Rs. 12-15 per 20 liter can.

The staple diet across states with regard to the study households exhibited more similarities than differences. Rice, *dal* (made from different pulses such as *moong*, *tuvar*, *channa*), vegetable/ curry (vary according to seasonal availability of vegetables) and *rotis* constitute the major items of the meals across states. There were some differences with regard to the method of preparation. For example, the *dal* in Tamil Nadu takes the form of *sambar* (a *dal* preparation with vegetables added to it) and *rotis* are rarely made; the *rotis* in Maharashtra take the form of *bhakis* which are made from flours such as wheat/ *jowar* (*jowar* during summers up till the arrival of rains and *bajra* during rains, through winter up till summers) and rice flour (rice *bhakis* are specific only to coastal areas). These differences in breads have particular significance for cooking and stove use, however, as we discuss below. In a tribal village in Madhya Pradesh, in the household of the Sarpanch, corn *rabri* (porridge-like preparation to be consumed with milk) was cooked on a daily basis as a side item with every meal and for breakfast. Fish is an integral part of meals in coastal villages of Maharashtra and Orissa. Across states, meat is cooked only on certain occasions because it is expensive. Food items such as sweets are made during festivities or on special occasions. In the study households in Tamil Nadu, food items such as *idlis* and *dosas* are prepared occasionally and it is only rice and *dal* which constitute the daily meals. A very interesting variation is with regard to consumption of leftover foods. There was a strong correlation between the economic status of the household and the consumption of leftover food

by that household. All households would try to cook the optimal amount of food. However, it was observed that the poorer households were more particular about cooking the exact quantity of food required for a meal. In case there were any leftovers, they would consume it for the next meal or the next morning for breakfast. In Orissa, leftover rice is typically soaked in water and fermented overnight to consume in the morning for breakfast. Also, in Tamil Nadu the rice and *sambar* is consumed for breakfast the next morning. In Maharashtra, the leftover *rotis* were consumed for breakfast by re-flavoursing it in the morning by breaking them into crumbs and cooking with spices and *masala*. The wealthier households which could afford to spend more on food would typically feed the left-overs to the cattle or give it away to their domestic help.

Table 3 below summarizes the variation in food patterns across the five states. The subtle variations in the cooking patterns depend on the regional cropping patterns across states. States such as Orissa and Tamil Nadu which are rice belts depend on rice as a staple diet, whereas states such as Madhya Pradesh, Uttar Pradesh and Maharashtra combine rice and roti in their regular meals. The coastal regions exhibit a pattern of regular consumption of fish due to easy availability. The small regional variations have significant impact on the design of locally made mud chulhas.

Table 3: Regional food patterns

<i>State</i>	<i>Roti</i>	<i>Rice</i>	<i>Dal</i>	<i>Veg. Curry</i>	<i>Non vegetarian</i>
UTTAR PRADESH	<i>Rotis</i> made of wheat/besan flour	Regular (Eaten alongside <i>roti</i>)	Staple (Regular <i>dal</i>)	Staple	Cooked rarely (Meat/Fish during festivities)
ORISSA	Rarely wheat flour <i>rotis</i> , during festivals special rice flour <i>rotis</i> made	Staple	<i>Dalma</i> - Vegetables added to the <i>dal</i> .	Regular (Cooked alternatively with non-veg dishes)	Staple (Fish in coastal areas) Meat bought rarely on festivities.
MAHARASHTRA	<i>Rotis</i> or <i>bhakis</i> (Wheat/ <i>jowar</i> / <i>bajra</i> / Rice flour)	Regular (eaten alongside <i>roti</i>)	Staple (Normal <i>dal</i>), <i>Pithla</i> - Flour from pulses cooked with onion and spices)	Staple (generally a dry vegetable)	Fish is a staple in coastal areas and meat on festivities.
TAMIL NADU	Rarely. <i>Dosa</i> (Rice flour based pancake, made during special occasions)	Staple	<i>Sambar</i> (Vegetable based stew)	Regular (Alternated with fish/meat)	Regular (Alternated with vegetables)
MADHYA PRADESH	<i>Rotis</i> made from wheat	Regular (Eaten alongside <i>roti</i>)	Staple (Regular <i>dal</i>)	Staple	Cooked rarely (During festivities)

Women typically decided what meals should be cooked, taking into account the likes and dislikes of all family members in the house. In rare cases (such as the household of the *Sarpanch* in a tribal village in Madhya Pradesh) the eldest man in the household directly specified what was to be cooked for meals every day.

Female perspectives:

Women in the study households mentioned that the act of cooking on a traditional cookstove came to them as easily as doing any other household chores. They thought it was mainly a matter of habit that made it easy. The design of the traditional cookstove allows the use of longer (up till about 2 meters in length) and bigger (up till about 4-5 inches in cross section) logs without having to cut them into smaller pieces (as is required for some more efficient cookstoves including the Philips stoves discussed below). As observed in the study households, during the entire process of cooking (which may vary from 1-2 hours depending upon the family size and the type and quantity of food cooked) the fire was tended every 10- 15 minutes. However, the respondents did not express any particular discomfort with this. They seemed to be doing it at ease. Preparation time before the main cooking starts was not looked upon as a major concern by the women, as it was done along with other activities such as cooking the rice and *dal*. This was also the time when the women in a household talk to each other or with men in the house to discuss family matters or with women from the neighborhood who would come into their house for a chat.

Firewood collection in most parts is seen as a social activity for the women. This takes from 30 minutes to 2 hours at different places and in specific places like the core village of Madhya Pradesh, which has a restriction on collecting firewood, a few households get together to cut down trees or leading heavy branches (these groups are either female or male groups from a few households). Women collect firewood as a secondary activity to their regular activities of collecting water from the community well. In households where there are cattle, the women mix husk with cow dung in order to make cow dung cakes, this is frequently used as a secondary fuel to complement firewood.

Respondents from across the study states stated that the food cooked on the traditional stoves tastes better than that cooked on modern cookstoves⁹ (such as the Philips stove/ kerosene stove) and on the LPG cookstoves (particularly *rotis*). However, the taste of the food cooked on the improved cookstoves such as ARTI and Gram Vikas models which are close to traditional cookstove designs was perceived to taste the same as that cooked on the traditional cookstove. In general, the household size surveyed upon was between 4-10 family members. On festivals and special occasions such as the harvesting season (UP – Sultanpur), Diwali (Maharashtra/Orissa), etc. families invite their friends and relatives over, on such occasions the mother-in-law and the sister-in-law help in cooking.

LPG cylinder does not have a regular supply into remote villages and middle men in many places add to the cost of obtaining a LPG cylinder. In both Lakhnipur (Uttar Pradesh) and New Buxipalli (Orissa), the nearest town is around 8-12 kms away from the city and the households surveyed had stories about having to pay extra money (bribe) to get LPG.

Male perspectives:

The male members across the study households across states were typically not engaged with helping out in cooking. The only household, where a male member helped during cooking was in the village of New Buxipalli (Gopalpur-Orissa). The reason could be that he was a young man, aged about 19 and would help out his old mother with cooking during his spare time. Most male respondents felt that cooking was an easy task as compared to other manual activities. However, most of them voiced their concerns about the smoke emitted from the traditional cookstoves. Though most of the study households were well ventilated, some smoke emitted from the fire would still linger around in the house during cooking. This would leave a black layer of soot on the walls and the roof. The male respondents felt that this necessitated a regular re-plastering and layering/ mud wash of the kitchen walls. The men help in collection of firewood when it is cut in bulk and stored for longer durations under the a shed or in an enclosed area to use it over a period of 2-3 months. In Madhya Pradesh, the men would help more often with collection of firewood since there were strict restrictions on the collection of firewood from the core forest

⁹ This does not refer to the traditional cookstove based designs of ARTI/ Gram Vikas.

areas. This necessitated bulking and stocking more regularly than only during summers. At places where there is an LPG connection, in most instances it is the male members who are responsible for replacing the LPG cylinders.

In regions such as UP and Orissa, major decisions are taken by the male earning member of the family, this includes decisions such as the procurement of a new stove and related issues. However, in Maharashtra and Tamil Nadu, respondents reported a more participatory approach of discussion among family members regarding the same decisions. The participation of women in making important decisions such as what appliances to buy for the kitchen and other house equipments was reported to be much more.

CDF's earlier fieldwork for the CDF-WRI clean energy project indicates some variations in cooking practices, especially with the kind of utensils being used and kitchen settings, within same geographical area depending on the religious beliefs of a household. It was observed that Muslim households have a common set of utensils for cooking all types of food, but in some specific Hindu households, non-vegetarian dishes are cooked in utensils

Fuel usage and collection:

The National Sample Survey data, 61st round (2004-2005) shows that firewood is the primary source of cooking fuel across India with a usage which is as high as 75 percent of the total rural household population. The reason behind this is the free and plentiful availability of firewood across India.

Table 4: All India Break up of Households by Primary Cooking Fuel

Primary Cooking Fuel	% of Rural Households¹⁰	% Urban Households
Firewood and chips	75%	25%
LPG	9%	57%
Dung cake	9%	2%
Kerosene	1%	10%
Other	4%	4%
No cooking Setup	1%	5%

Data source: National Sample Survey, 61st round (2004-2005)

¹⁰ The total does not add up to 100% due to the rounding effect

Type:

Across the states, firewood was the primary fuel but a multiple varieties of fuel are used to complement the firewood including cow dung cakes, dry leaves, dry grass, hay, husk/ chaff/bran/corn cob, and coconut husk. The type of firewood used depended on the availability of the stock in the near geographic area. For example coastal villages of Orissa used casuarina branches as a regular source of fuel, with coconut husk/corn cob as alternatives. All study households could not afford to keep cattle and thus, their access to cow dung was limited. Across states, villages that are relatively better connected to semi-urban areas have access to alternatives such as LPG. Kerosene, as pointed in the above section is used as another secondary fuel up to the limit of the rationed kerosene procured.

Quantity used:

The quantity of firewood used in the traditional cookstove is between 1-1.5 kgs per cooking of a meal and the size of the logs used is large (1-2 meters), which can be reused if not completely burnt. As mentioned before, most of the households profiled cooked two meals a day. Households in coastal villages in Orissa such as Tamna did not put out the fire but rather let it smolder through the day,

In the core village of Narsingharh sanctuary in Madhya Pradesh, the villagers are forbidden by the forest department from venturing into the jungles for firewood collection, however people form small groups of 10-12 and venture into the forest areas cut trees which are used for stocking firewood. They try to do it discreetly, so that the forest officials do not discover logging activities. Mostly firewood was collected for 2-3 months at a single stretch; this ensures that the villagers do not have to venture out into deep into the forest regularly.

which helped them keep the food warm and saved them the trouble of trying

Gopalpur (Buxipalli village) coastal area in Orissa has the presence of army training camps, which usually deters people from going too deep towards the sea for the purpose of collecting firewood. The women of the household go to collect the firewood themselves and the collection is done twice a week. Women have to pay an entry fee of Rs 5 to enter the defense lands to collect firewood. One of their biggest fears is that they might get shot during the defense shooting practice. Collection of firewood is usually a social event and takes around 2 hours in the coastal areas of Orissa.

to re-ignite the fire. The reason for this was the easy and free availability of casuarina branches across the region.

In most states there was a practice of stocking firewood collected for longer durations. In Madhya Pradesh and Maharashtra the households surveyed collected and stocked firewood for up to 2-3 months. The firewood was generally stored outside the house in the front yard

or backyard. Only the amount of firewood for immediate use was stored in the kitchen near the stove. During monsoons, the firewood is moved either inside the house or is stored under a shed-like enclosure to protect it from getting wet. Wet firewood takes longer to burn and does not burn as efficiently as dry firewood and produces a lot of smoke when it burns. It also requires additional kerosene when igniting it.

Collection:

Collection of fuel is an indispensable activity towards cooking and has been internalized, meaning people see it as a part of their day to day activities and in specific places it was also seen as a social get together. Thus, to a great extent, people collected firewood without finding it to be too cumbersome. Firewood was collected from nearby areas, approximately at a distance of 1-3 kms depending on the density of tree cover in the near vicinity.

The main equipment to collect firewood is an axe, a rope to tie the firewood in piles and cloth headgear to carry the firewood back home. It was usually the women in the households who are engaged in firewood collection, though in some instances men in the households helped with the task. Women were the main collectors in households that collected firewood on a regular basis (every two to three days) whereas men are involved in collecting firewood only when it had to be collected in bulk due to the rains or legal issues. The reason for this could be that cooking and cooking related practices are perceived to be the primary task of women in the households and the men are reluctant to engage with it on a daily basis. Availability of firewood is an issue during the rains or in areas such as wildlife sanctuaries and national parks where there is restriction on collection of firewood. The supply chain linking LPG to remote areas is underdeveloped in most states. People shift to alternatives during rainy season or incur an additional cost in collecting the wood and storing it at a dry place. Some women respondents mentioned that they prefer collecting the firewood themselves because the men usually get firewood which is too big in size, hence it is an added task for the women to cut the larger fire wood stock into smaller pieces to fit the *chulha*, which takes up a lot of time. It was far easier for the women to cut/collect the right sized firewood from the trees than from collected pieces of log.

Cost:

Across all the states where fieldwork was conducted, most people collected firewood for free. Some households in Tamil Nadu which do not have access to firewood in the near vicinity pay for firewood. In Maharashtra, households which possess land, hire a shepherd to cut and collect firewood on their lands. Instead of paying the shepherd, they allow his cattle to graze on their lands. In some instances, households hire labour for a day (approximately Rs. 40-50 per day) to cut and collect branches of trees grown on their own lands.

Combustion/Smoke:

Most of the women in the households studied seemed to have achieved a sort of comfort level with the smoke produced from the burning of firewood. The discomfort caused from the smoke is mitigated through different ventilation mechanisms. For instance, in Orissa and Uttar Pradesh, the cookstoves are usually built outside the house where the smoke is directly let out into the atmosphere without bothering the women who are cooking. Rural households in Maharashtra and Madhya Pradesh have traditional systems of filtering out the smoke. In Madhya Pradesh, there is a significant gap between the wall and the roof of the houses and an opening in the roof, both of which help in letting the smoke out. Similarly, in Maharashtra, the cooking area's walls are typically made of cane/wire mesh that helps in letting the smoke out. The only exception was a poor household in Kihim (Raigarh district), a coastal village in Maharashtra, where the stove was located in an enclosed area outside the house with no ventilation at all. Smoke was trapped in this enclosed area. The woman who was cooking in the household would put food for cooking on the stove and come and stand outside the stove area. This problem could be easily solved by making provision for ventilation.

Cleanliness of the stove:

The traditional cookstoves in the study households were fairly well maintained and clean. The process of cleaning was fairly uniform across regions and households, with very small variations

with respect to differences in the frequency and timing. The cleaning process can be summarized as follows:

Dry cleaning - Generally, the outer surface of the stove is cleaned with a simple piece of cloth or a small broom after cooking every meal. This is a very quick cleaning to remove any spill from cooking or any particles of ash from the burning of the fuel.

Removing the ash - After the cooking is over, the fire is either left to slowly extinguish on its own, or, if the flames are strong, either a little amount of water is poured on the fire or the burning log of firewood is removed and shoved into the ash to extinguish the fire. The ash from the previous cooking session was removed either after every meal was cooked or only once a day depending on the space available in the stove to hold the ash as well as to have enough room to place the fresh fuel for burning. There were no fixed regional patterns of variation observed in this regard. It was more a variation across households in different states. Ash was removed only once a day in all study households across states, except for two households in Kihim, a coastal village in Raigarh district of Maharashtra, both of which used brick cookstoves,. The removal of ash took place either early in the morning or at night after the meal has been cooked and after enough time has passed after cooking to ensure that the ash has cooled down. This ash was mixed with cow dung and used in the fields as manure by households owning their own lands. It was also used for washing vessels, sometimes mixed with mud or detergent powder. Another use of the ash powder was to mix it with water and layer the bottom of new vessels before setting them onto the fire to prevent blackening of the vessels. The excess ash is simply thrown out.

Clay/ Cow dung wash and plastering: Clay wash and layering of the stove is a regular practice for users of the traditional clay cookstove. The frequency of this activity varies from once a day (mornings before beginning to cook) to once in every 3-4 days or even once in 8 days. Once the ash is cleaned from the stoves and cleaned with a broom or cloth to remove any excess dust or ash, the stove is ready for a wash and layering. Mud/ clay is mixed with water to form a paste. Cow dung is mixed with the clay for an added binding effect. This mixture acts as cement helping to fill cracks to repair the stove.

User Experience with Improved Cookstoves

Methodology:

This part of the study focused on understanding user experience with some of the leading improved cookstoves (alternately called fuel-efficient biomass cookstoves or smoke-less cookstoves) that have been introduced in India. The study of traditional cooking practices and the activities that surround them are important for developing a robust sense of user requirements for the next generation of improved cookstoves. It is also important to understand how users interact with new cooking technologies that are available and their perceptions with regard to the same. Often, experience with specific alternatives raises questions and suggestions for improvement that are hard to elicit when asking people to consider hypothetical situations. Also, there is little clarity on the willingness of the users to adjust their traditional cooking practices to accommodate new technology and peoples' reactions to new technologies, in particular product features they most value and most resist, provide some insights into factors that affect willingness.

The major improved cookstoves in the market are models from Envirofit, B.P. Oorja, Philips, TIDE, ARTI. Early improved cookstoves were deployed via the government and NGOs, either free to the end user or at highly subsidized rates. More recently, however, social enterprises have attempted to sell stoves, at near full cost, through more traditional retail channels and MFI product financing such as the Envirofit and Grameen Koota (MFI) linkage in Karnataka, where Grameen Koota was providing a small loan to the end users to purchase Envirofit cookstoves. To date, the majority of improved cookstove users have received stoves at below market rates. As a result, this user experience study deals with a user population that has not necessarily purchased stove at full cost (so we cannot assume that they chose and/or necessarily value the stove) and one that has likely been exposed to some degree of customer education through NGOs. On the one hand, the fact that the stove-using population is likely to include skeptics as well as fans who are willing to pay is a plus for the study. On the other hand, the fact that most communities have been exposed to customer education means that they may be more aware of environmental or health benefits in addition to their experience.

ARTI improved cookstove based on traditional cookstove design, Maharashtra:

The Appropriate Rural Technology Institute improved cookstove (Laxmi cookstove model) draws much from the design of the traditional clay cookstove. It is a two burner cookstove, with a metal cast in the fire place, which is meant to burn the firewood more efficiently than traditional stoves. It also has an air inlet to ensure a continuous supply of oxygen. The cookstove has a chimney which is attached to burning area of the stove which carries the smoke from the cookstove out of the house through the roof. A study of the user experience of this ARTI improved cookstove was carried out in a village in Maharashtra (District: Satara, Block: Phaltan, Village: Kapashi) where the stoves have been installed. These stoves were installed in the village in the year 2005. The model of stove distribution in the village was based on a cost-sharing mechanism. Each stove cost Rs.300, out of which Rs. 150 was paid by ‘Art of Living,’ a national organization founded by Sri Sri Ravi Shankar operating in the village, and Rs. 100 was the subsidy from ARTI. Thus, the end user/ beneficiary had to pay just Rs. 50. Out of the total 200 households in the village, approximately 160 households had opted for the ARTI improved cookstove. The reason for the remaining 40 odd households not availing the subsidized improved cookstove was either because they could not afford to spend Rs. 50 on a cookstove or they did not perceive the need to replace their traditional clay cookstove with the improved cookstove.

Most of these 160 households have continued to use the stove for the last 4 years. The households who have stopped using it did so mainly because their cookstoves were damaged during the renovation of the house or due to some other reasons. Replacing the cookstove is expensive now, since the subsidy is not available any more. No household in the village has bought the improved cookstove at its full price yet.

The fuel used was the same as that used in the traditional cookstove: primarily firewood but also cow dung, dry leaves, and hay. The method of lighting the fire and tending it is similar to the traditional cookstove. A marked observation is that, in spite of the claims made by the improved cookstove design that one does not need to blow air into the fire very often to keep the fire burning, the women kept on blowing air into the fire. In one of the study households, during the entire period of 1 hour 15 minutes taken to prepare a meal, the woman used a blow-pipe to blow

air into the fire approximately 6-8 times. The woman mentioned that this was not cumbersome for her in any way, since she had gotten used to doing it even on the traditional stove. It was observed that the inlet for the air supply of the stove was blocked by mud which had collected next to the opening of the inlet, which partially blocked the air supply to the fire. When the respondent was asked about the same, she said that this did not matter all that much. Even if the inlet is cleaned and left open, it does not ensure enough air supply to the fire and blowing with the pipe was necessary to keep the fire burning. However, end users feel that less firewood is used when they use the improved cookstove which means that the wood burns more efficiently in the improved stove as compared to traditional cookstove. All the other practices surrounding cooking with the improved cookstove are the same as in case of a traditional cookstove. The LPG cookstove is used as a secondary stove to make tea, for quick cooking or when guests arrive to basically save on the time spent in lighting the firewood (which is on an average 10 minutes).

When the improved cookstove is lit for the first time, cracks develop in it, especially in and around the burner area, this necessitates regular layering with clay and cow dung, every 6-8 days, to hold the cracks together and prevent any further cracking. Though cracking and layering to prevent from further damage is common with the traditional clay cookstoves, the users were hoping that since the ARTI stove is an improved version of traditional stove, this problem should be take care of.

Though most study households have some sort of ventilation for the smoke that is produced by the burning of firewood, some amount of smoke remains lingering in the house before it is completely ventilated. In case of the improved cookstove, however, there is no chance of even this small amount of lingering smoke to be left behind since, the chimney carries out all the smoke from the stove to outside the house. It was observed that there appears to be a reduction in the amount of smoke trapped inside the house as compared to the case of a traditional cookstove. However, the purpose of the chimney gets defeated in instances where small sized vessels are placed on the burner with the help of three stones hedged at the rim of the burner and smoke is let out from the space left between the burner and the vessel. When the stove was initially installed, the users were given a metal plate which functioned as a size adapter for the burner to suit the size of the vessel. Using this metal plate, however, caused cracking of the burner rim

and was thus not very usable. As in a traditional cookstove, this problem was repaired with a regular mud layering job. Since most of the smoke escapes through the chimney, the amount of soot left on the walls and roofs is significantly less. Also it is more comfortable to remain in the cooking area while the stove is burning since the amount of smoke trapped in the house is noticeably less than traditional stoves without chimneys.

Respondents felt that the taste of the food cooked on the improved cookstove was exactly the same as the taste of the food cooked on the traditional cookstove.

Gram Vikas (based on ARTI improved cookstove¹¹), Orissa:

The respondents in the tribal village of Tamna in Orissa were using energy efficient stoves provided by the NGO Gram Vikas. The market price of this cookstove is around Rs. 280. However, Gram Vikas had subsidized the cookstove by doing away with the making charge of Rs 80 and employing its own technicians to help the beneficiaries in building the stoves. The raw materials required for the stove such as metal plates and chambers were also provided at subsidized prices by Gram Vikas. The household contributed to small investments by purchasing the chimney pipe and providing the mud. The male member from the household also contributed his time in assisting the Gram Vikas technician to build the stove. The design of the stove is very close to the traditional clay cookstove with the exception of having a metal plate inside, which improve the insulation of the cookstove to burn the wood more effectively.

Gram Vikas has promoted the stove in the remote tribal villages of Orissa through a lottery based system. Households were picked randomly in the first round and for the second round most of the households were interested in adopting the new design stove.

The cooking practices around the stove remain the same as the traditional cooking practices around the traditional clay cookstove. The stove does not reduce the amount of firewood used

¹¹ This stove is a modification of the ARTI model to suit the local material availability. However, ARTI does not have any role in designing or maintaining the stoves. According to Duflo et al (2008), Gram Vikas has randomly assigned improved cooking stoves to households. These stoves have a chimney and when properly used should reduce indoor air pollution with in the household. Follow up studies are to reveal if improved cookstoves reduce smoke exposure and improve respiratory health.

significantly, however, because of the chimney most of the smoke is let out of the kitchen. The users were more pleased regarding the reduced blackening of the walls due to reduced soot from the smoke than with regard to the improved air quality.

Philips energy efficient cookstove, Uttar Pradesh:

The energy efficient Philips cookstoves were distributed free of cost to 8 households in a village with a predominantly Muslim population in the state of Uttar Pradesh (Village: Khairatpur, Block: Jagdishpur, District: Sultanpur). The Energy and Resource Institute (TERI) is the main organization involved in deploying the Philips cookstoves to get a feedback from the end users. These 8 households were selected on a consultative basis with the *Sarpanch* (the political head of the village). The following are the findings from a FGD carried out with women users from 5 out of these 8 households. The participation was constrained by an unforeseen event (death of a village member) that was encountered during the study.

These stoves were distributed in April 2009. All the 8 households who had received these Philips stoves have been using the stoves on a fairly regular basis since then. However, it is important to note that these households are using a combination of stoves i.e., the traditional clay cookstove, LPG cookstove (out of the 5 respondents 3 mentioned that they had a LPG connection) and kerosene cookstove along with the Philips cookstove.

The Philips stove consumes about 15 kg of firewood in 1 month to cook food for around 10 people. On the other hand, if LPG were to be used to cook the same quantity of food, one single LPG cylinder (which costs about Rs. 300) would last for just over a month. Hence, using LPG as a primary fuel for cooking turns out to be more expensive and thus is used only for making tea or when there are guests at home and there is not enough time to light the fire wood in the traditional cookstove.

Electrically charging the Philips Stove:

The Philips cookstove needs to be electrically charged for at least four hours. This charge last for a week's cooking. When the stove is charged the bulb shows a green light, when stove is running out of charge the light turns red, which is an indication that it needs to be recharged. The electricity in the village is fairly regular (a minimum of 5 hours a day) and there is a scheduled time for load shedding, so charging the stove is not much of a problem.

Fuel used for cooking:

Only pieces of firewood 6 inches long or less can be used in the Philips stove. Dry leaves, hay, twigs, agricultural waste, husk/chaff/bran and cow dung are not meant to be used in the Philips stove. The respondents reported that cow dung used in the stove burns out very fast and produces more smoke than firewood. Similarly, other fuels would not burn as efficiently as firewood.

The greatest problem facing the users of the Philips cookstove is that it requires the usage of only small chopped pieces of firewood, which necessitates chopping the firewood readily found in the form of thick long logs of wood into smaller pieces. This is a tedious job and requires some amount of physical strength and energy. This and the time consumed are viewed as an additional burden. The users are of the opinion that only if this issue was addressed by the stove design or by readily making available the chopped pieces of firewood, it would significantly increase the convenience of using the Philips stove. Generally the men in the house help out with the chopping of wood, but if they are busy with some other work or have gone out, the women feel constrained and find it cumbersome to do the chopping themselves. In that case they use the traditional stoves or LPG stoves.

Duration of cooking:

The respondents use less firewood in the Philips stove as compared to a traditional chulha. When the same amount of firewood is burnt, it produces more heat in the Philips stove as

compared to the traditional cookstove. This means more heat will result in lesser time to cook. Also, the inbuilt fan in the Philips cookstove ensures that there is a regular supply of oxygen to the fire and hence it saves the trouble of tending the fire or blowing air into it. Food cooks faster on the Philips stove compared to the traditional stove. For example, rice and *dal* get cooked faster on the Philips stoves and thus it saves cooking time. Though the cooking is faster it is still gradual and not sudden, thus, the question of watching food (for spills/ getting burnt) while it is being cooked is not a major concern. For most of the cooking process, the women remain in the vicinity of the stove and thus can easily watch the food on the stove.

However, the overall cooking time could be longer than with the traditional cookstove. First, the wood needs to be chopped as mentioned above. Second, the Philips stove has only a single burner and thus two dishes cannot be cooked simultaneously on it. One has to first wait for the rice to cook, then the *dal*, then the vegetables and then the *rotis*. Thirdly, since the stove is a top loading model, the vessel has to be taken off the burner to reload the firewood. All these contribute towards extending the total time required for cooking a meal. The shifting of the vessel from the burner to the ground and back to the burner is seen more as a matter of inconvenience than a matter of danger or a physical hazard since, the women are used to easily maneuvering the vessels. However, it may be a hazard if children are moving around in the vicinity and may tumble over a vessel and spill food or get burnt from the hot vessel.

Mobility of the Stove:

The stove can be carried to different locations in and outside the house, this helps especially during summers when the kitchen is very hot, as the stove can be kept in open areas or near a fan. But the flip side of a mobile stove is that it can topple easily. It may be dangerous if there are children playing in the vicinity.

Exceptional case: Ramzan

“During Ramzan, we practice Roza (fasting), the cooking happens once before dawn and later in the afternoon, since we have to consume food before sunrise and later after sunset. During Ramzan since the cooking is more elaborate than usual and also due to time constraints, most houses used a combination of the Philips stove, the traditional cookstoves and the LPG/ kerosene stoves.”

Cleaning of the Stove:

Since the Philips stove is a top loading model, it has to be inverted each time to remove the ash. Though the stove is not very heavy, it is an added task for the women to lift the stove and invert it to remove all ash from it. This was perceived as being very inconvenient. Also, they are used to cleaning the traditional cookstove and report facing some difficulty in shifting to this new process of cleaning the stove. However, the amount of ash produced after burning the same amount of firewood is much less in the Philips stove as compared to the traditional stove. Also the ash from the Philips stove is whitish in colour and not blackish as in the traditional stove. This helps to keep the inside and the outer surface of the stove cleaner as it does not easily get blackened with ash.

Preference:

The users reported that the taste of food cooked on the Philips cookstove was almost the same with regard to *dal*, rice, and vegetables but there was marked difference between the taste of *rotis* made on a traditional cookstove and those made on Philips/ LPG stoves. *Rotis* are typically cooked first on a flat pan (*tawa*). Only a small sized *tawa* can be used on the Philips cookstove because if a large sized *tawa* was to be placed on it, it would not spread the heat evenly to the entire surface area of the *tawa*, concentrating the heat only at the centre and not spreading it sufficiently to the sides of the *tawa*. This would result in the *roti* not cooking well thus only small sized *rotis* can be made on the Philips stove using a small sized *tawa*. However, since most families in the villages are large sized, making bigger *rotis* is the general practice. Some kinds of *rotis* like the ones made from Besan (Chana dal / gram flour) are thicker than the wheat *rotis*. The traditional way of making the Besan *rotis* is to cook it partially on a *tawa* and then put it on the burning firewood next the mouth of the stove from where the fuel is fed. This process bakes the *roti* completely. The respondents mentioned that these Besan *rotis* could thus be cooked only on a traditional stove and not on the Philips/ LPG stove.

Smoke:

There is significantly less smoke in the Philips stove as compared to the traditional cookstove. This contributes to a great extent to the comfort of cooking. However, the health benefits from less exposure to smoke are not felt so strongly as much as the ease of having less smoke being emitted and lesser soot on the walls reducing blackening of the walls.

What matters with regard to cookstoves?

Current improved cookstoves which are the most cost effective ranging between Rs.150-Rs. 300 are the invisibly designed stoves such as the ARTI model. This model does not deviate much from the traditional design of the stove, which reassures the end users that they are using a product which they have used before.

In forced draft models such as B.P. Oorja and Philips, the fan regulator gives an impression of being closer to a LPG cookstove. This is evident from the responses of the users in Khairatpur who mentioned how they liked the fact that they could actually regulate the heat. However, the top loading model does not hold enough fuel to be able to cook for larger households and refueling the stove midway through cooking is one of the problems faced by the end user.

Consumers also prefer using larger pieces of log that need to be tended to sparingly as it gives them the freedom to move around doing regular day to day activities along with cooking. People also perceive the possible risk of children toppling over the Philips/B.P. Oorja/Envirofit design stoves which are stand alone units. This risk is not present in case of fixed stove models such as the ARTI/Gram Vikas models.

Aspects such as efficient combustion of fuel were viewed upon casually in most of the households studied as the availability of firewood is in plenty and it is free of cost. End users would prefer to regulate the heat in a more efficient manner, so that they can cook better. Consumption of firewood was a constraint at places where the people paid for fire wood. However, that does not happen in many places around India. Even in places where cutting of firewood is prohibited, people found ways around the law to access firewood.

Respondents perceive LPG cookstove as a modern cooking technology and as a status symbol, however, given the current prices (as against free availability of firewood in most cases) and the supply chain network, they also understand that switching entirely to LPG as a primary source of cooking fuel is not a practically and financially viable option. Many households interviewed believe that food cooked on the traditional clay cookstove tastes better than the food cooked on LPG cookstove, particularly *rotis*. People see value addition in an improved cookstove when it resembles the LPG stove in terms of design or utility value. Thus companies designing efficient cookstoves need to keep in mind that people will not pay a premium for the product if they do not see a perceived improvement from the stove.

Cookstoves closer to the LPG design with features such as the Philips/BP Oorja model with a fan regulator and ARTI/Gram Vikas/Envirofit design stoves with two chambers have good acceptance levels. This is because they address the aspiration of the end users of being not only close to LPG visually¹², but also having utility values closer to LPG, such as being able to cook the meal faster or slower by regulating the heat (Philips/ B.P. Oorja) or being able to cook multiple dishes at the same time (ARTI/ Gram Vikas/ Envirofit). If the stoves are fixed and built within the house, then the stoves need to have a chimney which can take the smoke out of the house. This is a significant feature in ensuring the uptake of the product.

Table 5 summarizes the major criteria that emerge from the field findings which are to be considered with regard to the cookstove design and its implications

¹² Envirofit/BP Oorja: Design wise they have a sleek outer surface made of steel and colour coated to look more attractive with one or two burners (Envirofit) and heat regulator functions (BP Oorja)

Table 5: Implications for cookstove design

Criteria for Cookstove Design	Description
Fuel	<p>Adaptation to local availability of fuel types, so that the locally available resources can be optimally used, in the most readily available form.</p> <p>Example: In Maharashtra, special domestically made oil can tin stoves are used to burn crop residue from wheat, jowar, bajra. In coastal Maharashtra and Orissa coconut husk and casuarinas are used as secondary fuels.</p> <p>In UP the major constraint to using the Philips improved cookstove was the necessity to use wood bits 6 inches or less in length, which had to be specially cut.</p>
Heat emitted	<p>The heat emitted should be maximally used between the stove chambers. Regulation of heat is an aspect which is looked upon favorably by end users</p> <p>Example: In traditional cookstoves people regulate heat by adding or removing pieces of firewood.</p> <p>Philips has a fan which regulates the air flow which increases or decreases the heat.</p>
No. and size of burners	<p>The studied households have a preference for a two burner stove so that they can cook more dishes simultaneously.</p> <p>Burner size adapters are helpful in adjusting to different vessel sizes and in better processing of the heat.</p>
Smoke	<p>The burner size should be well adapted to the vessel size, minimizing the smoke emitted outside the chulha.</p> <p>Blackening of the walls from the soot for chulhas built inside the house was a major concern among more studied households.</p>
Taste/ Preference	<p>Rotis which constitute a major part of the staple diets in most study households use high flame over a shorter span of time and the roti after being partially cooked is put directly over the fire, where as rice and dal require a steady flame over a longer duration to be cook well. This is one of the major differences which would have significant implication for the design of a cookstove.</p>
Fixed vs. Non fixed	<p>Some households prefer the fixed stoves over the mobile ones to eliminate the possibility of it toppling over when the food is being cooked or when children are around. At the same time other households prefer the mobile stoves as it can conveniently move inside and outside the house during rains.</p>
Appearance	<p>Respondents prefer darker coloured stoves as it is easier to maintain and does not easily get blackened by ash</p>
Ritual design	<p>Observations from study households suggest that this not an integral part of cookstove design or cooking practices. Only exception: Fisherman’s household in coastal Orissa, designs drawn around stove during festivities</p>

This study points to the fact that, people are willing to shift from using traditional cookstoves to using improved cookstoves only if they perceive a real utility value in adopting the improved cookstove. Apart from considerations like ability and willingness to pay, the success of improved cookstoves depends much on its design. The design must be well adapted to people's needs keeping in mind the general design principles of efficiency, emission reduction and ergonomics. The usability of the improved cookstove depends on whether or not the design of the stove takes into account the subtle variations in cooking practices across regions and the availability of local natural fuels.

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