

Differences in firewood users' and LPG users' perceived relationships between cooking fuels and women's multidimensional wellbeing in rural India

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Supplementary Information

Differences in firewood users' and LPG users' perceived relationships between cooking fuels and women's multidimensional wellbeing in rural India.

Supplementary Note 1: The Capability Approach

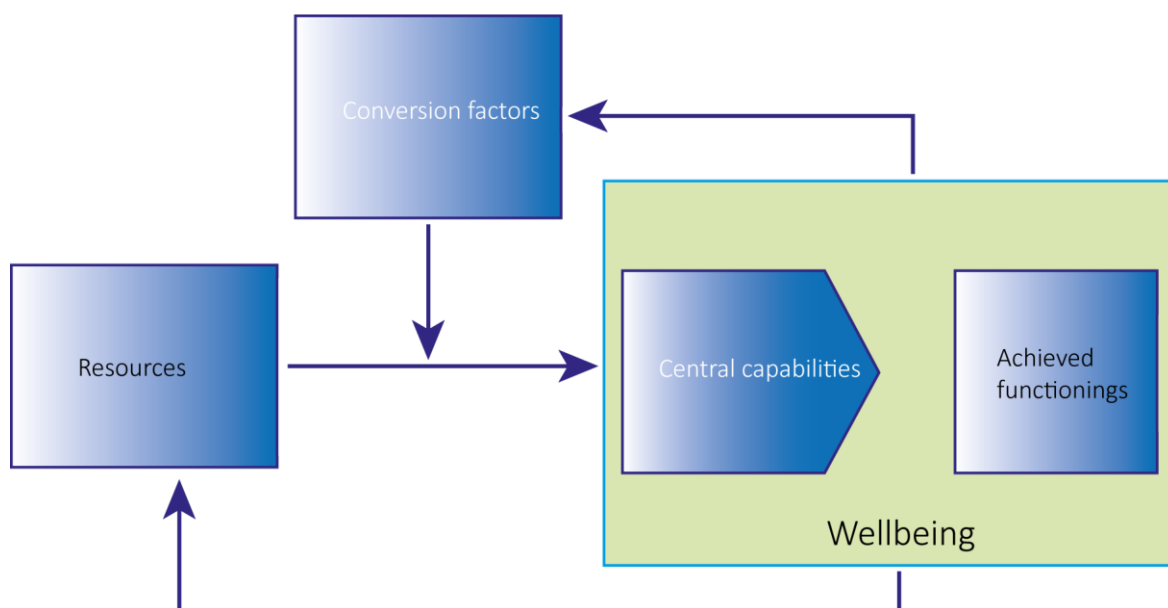
The capability approach (CA), after Sen ¹ and Nussbaum ² is a normative framework. Two important concepts underpin the CA, 'functioning' and 'capability' ^{1,3}. Functionings are the things/states that a person values doing or being, such as being nourished and healthy, or having meaningful relationships ⁴. A capability refers to the substantive freedom or opportunity to realise a valued functioning ⁵.

One important feature of the capabilities approach is that it focuses on the opportunities that people have and the outcomes that they can realise, rather than on the resources or commodities that they are able to consume ⁶. It therefore takes into account that there is variation in people's ability to convert resources to capabilities, for reasons to do with personal abilities and characteristics, and social, physical and institutional context (sometimes referred to as conversion factors) ^{3,7}. Most pertinently for our analysis in this paper, it is an explicitly multi-dimensional conceptualisation of wellbeing, recognising that a number of non-substitutable capabilities contribute to wellbeing.

Supplementary Figure 1 represents a simplified schematic of the relationship between resources and wellbeing in terms of capabilities. While resources can be converted to capabilities, it is also the case that capabilities and functionings can affect access to resources, and also impact on how resources can be converted to commodities, i.e. the conversion factors. Previous work has linked energy and fuel with capabilities, generally positioning energy or fuel as a resource that underpins the realisation of capabilities ⁸⁻¹⁰ and also pointing to the recursive relationship between some capabilities and access to energy ¹¹. In this paper, we take cooking fuel as the resource of focus, and are interested in the links that women see between this resource and various important capabilities.

Although the CA is a well-established framework for assessing wellbeing, several criticisms exist. Gasper ¹², for example, argues that Sen's CA is more inclined towards theory of policy rather than a theory of wellbeing because the assessment of capabilities is more applicable to measure a person's advantages as an outcome of public policy implementation. As our work is oriented to energy policy, this criticism is not a concern in this case. Navarro ¹³ disagrees with Sen's reference to freedom and liberty without connecting them to the political context, which has a critical role in influencing a person's quality of life. In similar line, Sayer ¹⁴ argues that irrespective of its recognition of socio-cultural context influencing people's capabilities, the CA does not sufficiently address why such contexts exist and perpetuate. These points are fair, but again do not invalidate the approach for our specific purpose. Further, Nussbaum ² also has disagreements with Sen regarding the importance of having a defined set of essential capabilities for universal application. Sen, on the one hand, rejects the idea of prescribing a universal set of capabilities externally ¹⁵, whereas Nussbaum has a specific list of 'Central Capabilities' ¹⁶. In the context of our study, we find Nussbaum's approach of using standardised capabilities for assessing wellbeing, particularly of women, more

useful as an analytical starting point but also note that it nevertheless allows, and requires, an elaborated conceptualisation of how these capabilities are arrived at in practice in the specific real world context ¹⁷.



Supplementary Figure 1. Relationship between resources and wellbeing, developed based on the Capability Approach.

Supplementary Note 2: Profile of the study villages

The fieldwork was undertaken in Chittoor district, which is situated in the southernmost part of the Indian state of Andhra Pradesh. In the 2011 census, the population of Chittoor was recorded as over 4 million ¹⁸, of which about 70% resided in rural areas. In relation to literacy, 71% of the population was literate, with women's literacy rate at 57%. Only 46% of the population was economically active, with the remainder classified as students, housekeepers, dependents, pensioners, and others. Around 90% and 98% of households used electricity for lighting in rural and urban areas respectively. In terms of household electrical appliances, the majority of households owned a TV and mobile phones.

The cooking fuel data for Chittoor appears typical for India. In 2011, around 86% of rural households in India relied on solid cooking fuels (firewood, crop residue, animal dung, coal, lignite and charcoal) ¹⁹. Similarly, rural households cooking primarily with solid fuels in Chittoor was around 80% ²⁰. Rural households using LPG for cooking was recorded at 11.4% and 17% in India ¹⁹ and Chittoor ²⁰ respectively.

Further, the census of 2001 and 2011 recorded four types of cooking fuels used in Chittoor, namely solid fuels, liquid petroleum gas (LPG), kerosene, and others (Supplementary Table 1). The data indicates solid fuels were the primary cooking fuels for most rural households, whereas the majority of urban households used LPG. Between 2001 and 2011, households using solid fuels in both rural and urban areas remained almost constant. More households in urban areas (additional 123 thousand) than in rural areas (additional 69 thousand) got access to LPG in the same period. The primary rationale for choosing the rural region of Chittoor to conduct our research was because of its higher reliance on solid fuels and lower LPG uptake, compared to the urban region.

Supplementary Table 1. Cooking fuels used in Chittoor in 2001 and 2011 (households in thousands).

Types of cooking fuels	Urban		Rural	
	2001	2011	2001	2011
Solid fuels (firewood, crop residue, animal dung, coal, lignite and charcoal)	60	64	603	585
LPG	76	199	56	125
Kerosene	35	28	10.5	6.9
Others	0.8	1.6	3.5	7.9

This study was conducted in four villages of Chittoor district. All the villages are located in the north-western border of the district, about 60 km far from Madanapalle, one of the economic centres of Chittoor. In villages 1 and 2, there were around 40 households each. Village 3 had around 48 households, and around 90 households in village 4. The majority of households in the villages relied on three occupations: livestock rearing; farming; and agricultural labour. The nearest LPG distributor was located within 25 kilometres of all villages (village 1 – approx. 24 km, village 2 and village 3 – ≤ 10 km, and village 4 – approx. 15 km). The distance to the nearest forest for all the villages was less than one kilometre.

The villages were similar in terms of electricity access and socio-economic status. That is, all the households in the villages were electrified, and, according to the participants and the village councils, all of them were classified as ‘Below Poverty Level’ (BPL). According to Government of India ²¹, households with average monthly per person per capita expenditure less than Indian Rupees 816 in rural areas are classified as BPL. No household reported having expenditure above the threshold. The villages were different in relation to caste and cooking fuels. Villages 1 and 2 belonged to ‘Other Backward Class’ (OBC), village 3 belonged to ‘Forward Class’, and village 4 had a mix of OBC and ‘Scheduled Tribe’ (ST). OBC and ST are identified as socially, economically and politically disadvantaged groups ²². Regarding the education level, all villages were similar. A rough estimate (generated based on the mass meetings) showed the villages had not more than 25% of population literate (village 1 = 18%, village 2 = 25%, village 3 = 20%, and village 4 = 20%). A majority of women participants had a basic level of literacy.

All households in village 1 and 2 relied primarily on firewood, and few households stacked LPG. In villages 3 and 4, all households used LPG as their primary cooking fuel and most stacked firewood as a secondary fuel. Although, in the literature, improved cookstoves are identified as intermediate technologies between firewood and LPG e.g. ²³, no household in the study villages reported using them. They reported having access to subsidised kerosene, which most of them sold to local kerosene dealers and some used for lighting purposes, in the case of electricity blackouts. It was apparent that fuel stacking, a widely reported phenomenon in the energy access literature ^{24,25}, was prevalent in all the study villages. For primary firewood users, a reason for keeping an LPG stove was to be able to use it when they wanted to cook something fast. In the minority of households that stacked LPG in villages 1 and 2, their LPG stoves remained mostly idle. For primary LPG users, stacking firewood had several purposes, for example, to use it when they ran out of LPG, and when having big gatherings where they had to cook for a large number of people.

Although caste discrimination is significant in India and is an explanatory factor for various developments ^{26,27}, the socio-economic status, despite some caste differences, was similar across the study villages. It is conceivable that village 3 could have some advantage, on the basis of their caste, for LPG uptake, but with only one village in our dataset that belonged to a forward class we were unable to ascertain that. Notably however village 4 had also transitioned to LPG despite not having

forward class households, implying that caste was not a barrier. Nevertheless, we recommend that future research on improved cooking fuel access in rural India should be attentive to the dynamics of caste.

Supplementary Note 3: Detailed analysis of the relationships between the cooking fuels and capabilities

Here, we present the detailed analysis that is discussed in the paper. We substantiate our findings with the help of the excerpts from the FGDs with firewood and LPG users. Additionally, existing literature is cited to strengthen our arguments. In the following sections, we first elaborate the analysis of the relationship between capabilities and fuels from the perspective of firewood users and then do the same between capabilities and fuels, based on LPG users' FGDs.

Firewood users' perspectives

Supplementary Table 2 shows the outcomes and possible outcomes of the relationship between the cooking fuels and capabilities, according to firewood users. A relationship with Affiliation was discussed 10 times for firewood and twice for LPG in the firewood user group discussions. We identified this capability when participants spoke in terms of being able to live with and towards others, to show care and concern for other human beings, to engage in various forms of social interaction, and to have the social bases of self-respect. All the references for firewood were positive, i.e. firewood users explained that firewood enables this capability. The three more specific outcomes or potential outcomes relating to this capability and linked to firewood were: (1) opportunity to socialise; (2) care for other family members; and (3) pursuance of traditions.

Supplementary Table 2. Outcomes and possible outcomes of the relationships between the cooking fuels and capabilities - Firewood users.

SN	Capabilities	Fuel	Outcomes & possible outcomes	Enabler/ Barrier	Total count
1	Affiliation	Firewood	Care for other family members	Enabler	2
2	Affiliation	Firewood	Opportunity to socialise	Enabler	4
3	Affiliation	Firewood	Pursue tradition	Enabler	4
4	Affiliation	LPG	Burden on children's education	Barrier	2
5	Bodily health	Firewood	Detrimental health effects	Barrier	17
6	Bodily health	Firewood	Improved health	Enabler	2
7	Bodily health	LPG	Detrimental health effects	Barrier	6
8	Control over one's environment	Firewood	Employment options	Enabler	5
9	Control over one's environment	LPG	Financial burden	Barrier	4
10	Life	LPG	Possible accidents	Barrier	2
11	Senses, imagination, and thought	Firewood	Preferred food taste	Enabler	6
12	Senses, imagination, and thought	LPG	Undesirable food taste	Barrier	5

In all the study villages, men were the primary breadwinners and had the principal responsibility of generating incomes. In a few responses, women said that *"Men do not have money, how they will buy LPG. We do not want to put pressure on our husbands"*. Although this statement reflects a financial problem, it also implies that women did not want to put a financial burden on men because LPG costs more than firewood. Therefore, such statements can be interpreted as signifying that by using firewood for cooking, women were demonstrating care and respect for their husbands.

Furthermore, in relation to affiliation, the activity of collecting firewood from forests was considered to be a valued opportunity for women to interact with each other. Participants said, *"We go to the forest with our relatives and friends"*, and, *"We discuss about our problems with each other while collecting firewood"*. Additionally, participants explained that the use of firewood was part of their ancestral traditions. They said, *"We were using firewood since generations before us"* and explaining their wish to continue it, *"this is our tradition passed on to us from our ancestors; we have to follow the same practice, and that is what keeps the community together."*

There was a further, less direct negative relationship identified between LPG and affiliation: some participants felt that the cost of LPG would jeopardise their ability to meet the costs of their children's' education. They said, *"Having LPG might affect our ability to meet children's school expenses"*.

As mentioned earlier, the capability most often connected with firewood use was Bodily health. Seventeen times the references were related to firewood engendering detrimental health effects, and only twice the cooking fuel was referred to as an enabler of health. Several health problems were reported by participants while collecting firewood, *"We get headaches, knee pain and shoulder pain"*; *"Some women get injuries while cutting wood"*. Regarding cooking, women reported for example, *"It is no fun cooking with firewood. It causes smoke, burning sensation in eyes"*. The references to firewood enabling health related to the integrity of food cooked over firewood: *"food cooked with firewood is tasty and healthy"*.

Firewood users also perceived LPG to have adverse effects on bodily health, making a total of six references along these lines. They reported, *"Cooking with LPG causes health problems"*. As the preferred taste of wood-cooked food was linked with its healthiness, so food cooked on LPG was believed to be both less tasty and less healthy *"Food does not taste good when cooked with LPG. It causes health problems"*. Furthermore, LPG was perceived to be Life threatening by firewood users (mentioned twice). For example, they said, *"We are afraid of LPG. If we keep it idle, it will explode and ruin our life"*.

An interesting relationship between the use of firewood and Control over one's environment emerged from the firewood users' discussions (mentioned nine times). For most participants, firewood came free of cost. They gathered it from the nearby forest, where they reported cutting only dead trees (although this did not fully align with LPG users' testimony about firewood use). Not only did they not need cash to meet their cooking fuel demand, but this also helped them to generate income. Participants referred to selling firewood as an employment option five times in total, and hence we identified it as an enabler of the control over one's environment capability. Being able to be employed, according to Nussbaum, provides a basis for control over one's material environment and gives a sense of self-respect and dignity ^{16, p.8}. Studies suggest that women's employment has multiple benefits, for example, enabling them to invest in productive assets and improve their status e.g. ²⁸. Participants highlighted, *"Mostly women sell firewood. Money from selling firewood is spent on the weekly markets"*. LPG, on the other hand, cost money, and participants believed that having LPG might put pressure on their household expenditure. This is

why LPG was identified as a constraint to this capability, four times in the discussion. They said for example, *“We cannot buy LPG... It is because we have some other problems at home, so that money is spent on that”*.

For firewood users, firewood only had an enabling relationship, and LPG only a limiting relationship with Senses, imagination, and thought (mentioned 11 times). An important dimension of senses, imagination, and thought is being able to have pleasurable experiences ¹⁶. Being able to enjoy food with preferred taste is a pleasurable experience, and hence we have interpreted it as part of this capability. Associations with this capability were recorded six times with firewood and five times with LPG in the firewood users’ FGDs. Participants noted that *“Food cooked with firewood tastes good”*, denoting such an experience. With regard to LPG, the responses from participants were quite the opposite: they stressed, *“Food does not taste good with LPG”*.

LPG users’ perspectives

Supplementary Table 3 shows the outcomes and possible outcomes of the relationship between the cooking fuels and capabilities, according to LPG users. Affiliation was the capability that we interpreted as most often mentioned in our FGDs with LPG users. We identified a total of 19 connections with either LPG (16) or firewood (3).

Supplementary Table 3. Outcomes and possible outcomes of the relationships between the cooking fuels and capabilities - LPG users.

SN	Capabilities	Fuel	Outcomes & possible outcomes	Enabler/barrier	Total count
1	Affiliation	Firewood	Care for children	Enabler	1
2	Affiliation	Firewood	Difficulties for children	Barrier	2
3	Affiliation	LPG	Care for children	Enabler	5
4	Affiliation	LPG	Care for other family members	Enabler	5
5	Affiliation	LPG	Improved social status	Enabler	5
6	Affiliation	LPG	Opportunity to socialise	Enabler	1
7	Bodily health	Firewood	Detrimental health effects	Barrier	4
8	Bodily health	LPG	Improved health	Enabler	7
9	Control over one's environment	LPG	Employment options	Enabler	7
10	Life	LPG	Possible accidents	Barrier	1
11	Other species	Firewood	Forest degradation	Barrier	2
12	Other species	LPG	Protect forest	Enabler	3
13	Play	LPG	Recreational activities	Enabler	2
15	Practical reason	LPG	Financial empowerment	Enabler	1
16	Practical reason	LPG	Fuel-choice decisions	Enabler	5
17	Senses, imagination, and thought	Firewood	Preferred food taste	Enabler	3
18	Senses, imagination, and thought	LPG	Undesirable food taste	Enabler	1

LPG users felt that using LPG enabled them to (1) maintain or improve social status and self-respect, (2) care for children; (3) care for other family members; and (4) have opportunity to socialise. For

example, with regard to their standing in the community they said, *"If we cook with LPG, people think that we have a high social status"*. Some participants explained that *"Everyone [relatives and friends] started buying LPG stoves. If we did not get one, it would have been a shame for us"*. This implies that maintaining the same social status as their friends and relatives, and avoiding shame, was important for them, and LPG helped them to achieve that. Similarly, LPG users repeatedly reported that LPG enabled them to show care and respect to their relatives. It transpired from the FGDs that hospitality and serving food was an important way to show such respect, and LPG enabled them to do this better as it cooks faster than firewood: *"If we have LPG and our relatives come unannounced, then we will prepare tea or snacks for them"*. It was reported that having LPG had helped them to take good care of their children. They said, *"We have small children, and we need to boil milk and water for them"*; LPG helped them to do this faster and more often, compared to firewood. Furthermore, as another dimension of caring for children, LPG helped them get their children to school, again due to LPG being a faster cooking option. LPG users explained that *"It [LPG] cooks fast. We need to cook fast because we have to send our children to school"*.

With firewood, on the one hand, some LPG users mentioned that the slower cooking time would cause difficulties for their children, *"If we cook with firewood, children may be late [for school] because cooking with firewood takes time"*, implying that using it in some circumstances would be a form of careless parenting. On the other hand, firewood was also positively implicated in care for children: it was mentioned that it was used as a (low cost) way to boil water for their children to bathe, which they valued. One participant said, *"We have children who take a bath every day. We use firewood to boil water for that purpose"*.

A total of 11 connections were identified in the LPG users' FGDs between Bodily health and the cooking fuels. There were two outcomes or potential outcomes mentioned by participants in relation to this capability, (1) detrimental health effects and (2) improved health. In relation to firewood, there were four mentions of firewood use impeding the capability to be healthy, especially for women. For example, discussing cooking with firewood, a group mentioned, *"some health problems with smoke, like eyes burning and breathing difficulties"*. No health-facilitating connections were made with firewood use. In contrast, LPG users explained 7 times how LPG has enabled an improvement in their health. They reported, *"eyes are not affected, hands are good, and dishes look good"*. Being able to get more sleep because of the reduced cooking time with LPG was mentioned a few times by participants. For example, in explaining her reasons for using LPG, a participant said, *"I want to sleep early. I want to finish cooking early and go to bed"*. LPG was, however, once mentioned in a negative association with the central capability of Life, the point being that LPG canisters have the potential for explosion, which could lead to deaths, particularly of children. A participant voiced their concern, *"People are afraid of LPG. We should be careful if we have children at home"*.

Turning to the capability of Control over one's environment, connections were made only with LPG, seven times in the group discussions. The perceived relationship mainly related to LPG enabling women to have employment options. As discussed earlier, being able to contribute to household expenditure gave women some degree of control over their material environment and a sense of self-respect. The identified relationship between LPG and employment options was, like some of the other connections made between capabilities and LPG, a rather indirect one in that it rested on the time-saving potential of LPG compared to firewood. That is, LPG reduces cooking time, which provided opportunity for women to spend more time on income generating activities, enabling their financial wellbeing. The majority of women reported being employed as casual agricultural labours.

As they said, *"We save time cooking with LPG, then we go to our agriculture work"; "If we want to go for work then we can cook fast, eat and go"*.

From the perspective of Nussbaum's capability approach, the ability to live with concern for and in relation to nature is an important aspect of wellbeing. A reason behind this emphasis is the inherent value of nature and human obligations to respect it because of the inevitable connectedness between the nature and human living²⁹. LPG users explained an enabling relationship between LPG and the Other species capability a total of three times, and a constraining relationship between firewood and this capability twice – these relationships related to forest health. They expressed their concern towards the forest if they continue using firewood for cooking by saying, *"We cut trees for firewood, and forest gets diminished"*. Further, they said, *"We bought LPG to stop cutting trees"*.

LPG users reported an association between LPG and the central capability of Play twice in the discussions. Being able to take time for recreational activities, sometimes with friends, was reported to be enabled by the use of LPG. LPG users said: *"We save time by cooking with LPG. We utilise the saved time to chat with our friends. We exchange our ideas like where to go for daily wage work. We also discuss our personal problems with friends. We start watching TV shows by 7 pm and finish by 9 pm. We watch TV together, which helps us forget our difficulties"*.

The central capability of Practical reason can be understood in part as being able to make decisions and overcome difficulties³⁰. It is also making decisions "about what it would be best to do, both in particular situations, and with reference to one's life as a whole^{31, p.25"}. In the FGDs, relationship between practical reason and LPG only was identified six times, always positively. This relationship was expressed mainly in relation to be able to: (1) make decisions due to the expansion of cooking fuel choices and (2) making decisions based on employment options. After adopting LPG, the users had expanded their cooking fuel options from one (only firewood) to two (LPG and firewood), a situation which provided them with an opportunity to choose their cooking fuel based on their need. Participants said, *"Having LPG is good because we can decide which fuel to use based on the given circumstances, for example, if we are tired, we use LPG, and if we are sick, we use LPG"*. This also exemplifies that this ability to make choices has associations with other capabilities, for example, bodily health. Being able to generate income had certainly empowered women to make their own decisions about what is good for them. Some participants reported that they did not have to ask for cash from their husbands, as they said, *"We use our own money to refill LPG bottles"*. Clearly, this relationship that we trace between LPG and practical reasons is quite indirect: LPG saved time, which was used to generate income, which increased women's ability to make their own decisions about what was good for them, including fuel choice.

In our group discussions with LPG users, on four occasions, participants described relationships between cooking fuel and Senses, imagination, and thought; one association was with LPG and three with firewood. We have already argued that being able to enjoy food with preferred taste is a way of having pleasurable experiences. Although all the LPG users had been using LPG for cooking, when it came to taste of the food cooked with LPG, they expressed their preference for firewood over LPG. Participants echoed, *"Food cooked on traditional stoves with firewood tastes good"*. One LPG using participant even said that, *"I cannot eat food cooked with LPG"*.

Supplementary Note 4: Focus group discussion guide

Note to the principle investigator

There will be six to eight participants in each focus group discussion (FGD). An interpreter will be assigned to translate languages. The principle investigator will be the main moderator of the FGD; the interpreter will assist when needed. The investigator will ask additional questions to maintain the flow of the discussions. Each FGD is expected to run for 1.5 to 2 hours. All the FGDs will be audio-recorded.

Checklist

- Distribute the project information sheets and the consent forms. Request a participant to read them aloud.
- Collect signatures on the consent forms.
- Audio record the consents.
- Divide the participants into smaller groups.
- Make sure everyone speaks and participate in discussion.

Semi-structured questions

1. Warm-up questions
 - a. Size of the villages and other demographic information
 - b. Major occupations
 - c. Cooking fuels
 - d. Electricity
 - e. Nearest markets (LPG distributors, hospitals, public transports)
 - f. Size of the families
2. Cooking fuel questions
 - a. Which cooking fuels do they use as the primary fuel? Who cooks? Where did they learn to cook?
 - b. How long have they been using this fuel? Who taught them which fuel to use?
 - c. How do they acquire this fuel (e.g. collect from the forest, buy from local sellers)? Also discuss how long it takes to collect the fuel from forest, who collects them, and how often?
 - d. How do they make decisions about cooking fuel choice? Who makes the decisions? What roles do they play?
 - e. Have they ever thought of switching their fuels? If yes, why? If no, why?
3. Wellbeing related questions
 - a. What are the reasons behind using the fuel? Discuss and list.
 - b. What are the aspects of the fuel they do not like?
 - c. What are the aspects of the fuel they like the most?
 - d. Why is the fuel preferred?
 - e. How the fuel is helping to run day to day life?
 - f. Is the fuel holding them back from what they like to do? Discuss and list.
 - g. Would they like to switch their fuel and why? If not, why?
 - h. How would the community support in case a household wishes to switch the existing fuel to a new one?

Contact details of principal investigator

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