Adoption of cleaner cookstoves: barriers and way forward

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Summary

Globally 2.6 billion people, representing around 38% of the total population depend on solid biomass fuels to meet their basic energy needs for cooking. While rural communities are shifting to modern fuels such as LPG and electrical energy for cooking, the International Energy Agency estimates that in the absence of new policies, the number of people relying on solid biomass will increase to over 2.7 billion by the year 2030 because of population growth, which calls for higher adoption rate of improved biomass cookstoves. This article highlights the key barriers to adoption of improved cookstoves, sharing experiences from the field in South Asia and Sub Saharan Africa. More emphasis on technical design of stoves to achieve higher thermal efficiency and lack of sufficient attention to consumer perspectives such as user-friendliness, purchasing capacity, income variability of rural households as well as to local capacity development of market players and stove builders create the dissemination challenge. The article suggests that stronger stakeholder partnerships, knowledge sharing, and satisfaction of user requirements through appropriate designs and diversified financing options will be required for a rapid growth of supply and demand of improved cook stoves.

Key words: Cookstoves, biomass, energy access, barriers

Introduction

With 2.6 billion people globally relying on solid biomass fuel such as fuelwood, charcoal, animal dung, shrubs, and agricultural residue for cooking, lack of cleaner fuels for cooking continues to be a critical issue (Pachauri et al, 2013). A vast majority of these people live in rural areas of South Asia and Sub-Saharan Africa. Although the "Sustainable Energy for All" initiative covers electricity and cooking energy access, there is little analysis of options or strategies for accelerating a transition to cleaner combusting cooking fuels or devices (Pachauri et al., 2013, World Bank, 2011). Many researchers argue that in the absence of new policies and strategies, the number of people relying on solid fuels for cooking will increase by the year 2030. The implications of these household cooking practices include severe health impacts, gender inequities, and local and global environmental change (Foell et al., 2011).

In India, the decrease in the consumption of solid fuels between the census of 2001 and the census of 2011 has been negligible. Five states namely, Andhra Pradesh, Bihar, Madhya Pradesh, Uttar Pradesh and

West Bengal account for nearly 50% of all households using solid fuel in India. According to the 66th round of the National Sample Survey, annually about 0.35 ton of firewood and chips per capita are consumed in rural households in India (NSSO, 2011). The per capita fuelwood consumption in the Himalayan country of Bhutan is even higher at 0.85 ton annually (Palit and Garud, 2010). On the other hand, 79% of the population in Sub-Saharan Africa use biomass as their main source of energy for cooking with annual average consumption of 0.8 ton of fuelwood per capita (Adkins et al., 2012).

While the need for action is clear, the technical barriers and institutional challenges to solve this problem remain daunting, and there are a number of areas where further work is required. This article, based on extensive literature review, stakeholder discussions and authors' field experiences, first briefly talks about the clean cookstoves programs and then attempts to highlight the key barriers to adoption of improved cookstoves (ICS) in South Asia and Sub Saharan Africa. Finally, it suggests some key measures that might be helpful to improve the user acceptability of ICS and enhance their dissemination.

Clean cookstoves programs

Recognizing the social, environmental and economic benefits of ICS, globally more than 160 ICS programs were running at the end of last decade, ranging in size, scope, type of stove disseminated, approach to technology design and dissemination and financial mechanisms (Gifford, 2011). Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) has been at the forefront in implementing ICS program in sub-Saharan Africa and in South Asia. In India, the Ministry of New and Renewable Energy (MNRE) was implementing the National Program on Improved Cookstoves (NPIC) for providing clean energy, but the program was discontinued in 2002. At the time of discontinuation, around 33.8 million ICS (around 27% of the target), have reportedly been distributed in rural India. Palit (2005) observes that one of the success stories of NPIC is from the state of West Bengal. This success can be attributed to the crucial role played by village level institutions, school teachers, youth clubs and women's groups for motivation, promotion and monitoring of the ICS dissemination. While India had a strong government based subsidised programme for ICS, in case of Africa, the delivery through entrepreneurs are more common.

The majority of ICS initiatives, either in South Asia or in Africa, seem to be focusing more on developing new stove designs, mass scale production and marketing and providing subsidies/incentives for wider dissemination and not enough focus is provided on socio-cultural acceptability issues. Balachandra (2010), citing the example of India, observes that the ICS programs were technology-focused with only dissemination being the objective and numbers deployed as the metric for measuring success. Further, policy makers have failed to influence a shift from biomass-based cooking in rural areas, and even the limited success achieved is confined to higher income rural families. While India launched the National Biomass Cookstove Initiative in late 2009, incorporating the lessons learned from prior policy initiatives, it has not been well organized, nor has it received adequate funding in comparison with the National Rural Electrification Program. The thrust on electricity access is also corroborated by the fact that almost half of developing countries have set targets for access to electricity, while very few have set targets in relation to access to modern cooking fuels or ICS (UNDP & WHO, 2009).

Barriers to Adoption

Providing access to modern cooking fuels and more importantly effecting a transition towards modern energy at the household level remains a challenge. The factors governing a household's decision to use a

particular fuel are very different from the case of lighting and these factors also differ from one region to another, making the goal of energy access for cooking more challenging. While affordability and the availability of a sustainable supply of cooking fuel is important, understanding the gap in behavioral aspects of household energy use is also critical to address the barriers. Further, barriers may also be geography specific; however, there are some common key barriers which seem to affect the dissemination both in South Asia and Sub Saharan Africa. Some of the key barriers to adoption of ICS are discussed below:

1. Overemphasis on technology, under emphasis on the user-friendliness

Most of the ICS projects across South Asia and Sub Saharan Africa seem to be technology-centric, focused on good designs from an engineering and designer perspective, and on improving the large scale manufacturing process (Ruiz-Mercado, 2011). Many a times, the products that were disseminated, hardly considered any input from the target users in the design aspect and therefore, were not used by consumers or were ill-suited for actual cooking. Gifford (2011) observed from survey of different projects that "stove too small to fit all pots" as the most common complaint amongst stove users.

In India, though millions of ICS have been disseminated under the NPIC, studies indicate that the key barriers to their introduction are both technical and social (Gopalan and Saxena, 1999). Even the best fixed ICS leak smoke into the room or are culturally not acceptable. The users thus tend to modify the design making it traditional again. For example, it was observed in the state of West Bengal, India that the pothole and mouth of the mud ICS are always adjusted by users to accommodate vessels of different size and to ensure that both fast and slow cooking can be done such that in early morning hours they can do fast cooking to prepare food for household members that go for work and in evening, they can do slow cooking while doing simultaneous household chores. In the absence of proper flame regulators in most of the natural draft ICS, controlling the flame is not possible. In case of forced draft ICS, while air supply can be regulated to provide remarkably clean burning, they require smaller wood chips (Raman et al., 2013). Users at large find the fuel processing tedious and in the absence of a market for processed fuel in rural areas, it restricts the adoption of these ICS. Further, most of the ICS are designed to use one type of fuel, mostly firewood, for optimum efficiency, while rural users prefer stoves that can take multiple fuels (such as twigs, leafs, straws and cow dung cakes) that are available in the rural areas.

Box 1: Example of technology barriers

In Bhutan, smokeless ICS was introduced as early as in 1985. Bhutan being a cold country, a major disadvantage of the smokeless cookstoves perceived by the users was the limited room heating and lighting effect. Although these smokeless stoves can be regulated to have a better efficiency, it appeared that in practice rural people do not regulate the airflow, thereby having a high combustion of fuelwood for heating requirement, thus reducing its efficiency as most of the hot flue gas escape through the chimney (Palit and Garud, 2010). Likewise, in many households in Bhutan as well as cold hilly areas in India (such as the north-eastern region of India) and Nepal, the first author observed during field surveys that chimneys of smokeless stoves were dismantled for using the smoke for drying chili, fish and grains, eventually making the ICS traditional again.

Similarly in Kenya, cooking *Ugali*, which is the traditional food, requires continuous stirring and so stove stability is essential. However, many of the available metal stoves are made of lower thickness steel with smaller base and are unstable making it difficult for the user to cook. In case of Ethiopia, the staple food *Injera* cooking requires wider flame (similar to *dosa* cooking in Southern region of India) and also consumes the maximum amount of fuel, whereas most of the available ICS are not designed to provide wider flame. A household thus has to buy two types of stoves for cooking *Injera* and curry, incurring additional expenditure, thereby restricting the procurement of ICS.

It is also observed that while we give a lot of emphasis on stove designs to achieve the highest thermal efficiency, very often we tend to neglect the kitchen design. Improving efficiency can help in reduction of fuel consumption and to some extent in reduced emission of particulates. But with improper kitchen ventilation the released pollutants remain inside the kitchen thereby exposing the occupants (Palit, 2011). While the major role of ventilation is to induce outside air to dilute the kitchen air so that pollution concentration remains low, field experiences show that in many cases the cookstove is installed away from the window or the kitchen does not have any ventilation, thereby allowing smoke to accumulate in the room.

2. Lifestyle change required to use improved cookstoves

Cooking forms a major part of a rural lifestyle, which includes gathering of wood with other women and cook traditional recipes passed through generations. While changes in lifestyle may bring significant benefits such as doing income-generating activities in the time saved on wood gathering but these changes are not easy to adopt. It can be difficult for women to adjust their cooking methods to a new device and it can be hard on family as the food may taste different. An evaluation of the Village Energy Security Program in India clearly indicates that communities were not inclined to use ICS because they were used to cooking on wood and were reluctant to change their cooking practices (Palit et. al., 2013). In a classic example of fuel stacking, many Indian households with LPG connections still use firewood based cookstoves, especially for bread making, due to perceived better taste of the food, and also affordability issues to some extent. LPG is used only sparingly for quick cooking such as making tea (Joon et al., 2009).

Further, fuelwood savings seems to have low attractiveness in rural areas, owing to their easy access to supply from homesteads, agricultural fields or nearby forests. A study of the Millennium Research Villages in Africa by Adkins et al., (2012) indicates that fuelwood used by majority of the households (79%) are acquired by collection. Poor rural households do not consider it beneficial to shift from biomass, obtained at zero cash outlay, to commercial cooking fuels such as kerosene or LPG or even processed biomass chips. The remote areas also provide low opportunity cost of labor and in many cases there is also minimal opportunity for cash income. Thus the savings achieved in terms of time and efforts in biomass collection because of reduced biomass use in ICS do not usually translate into tangible benefits as they cannot always utilize the time for income generation activities.

3. Purchasing patterns by households

It is the woman who would benefit the most from the ICS but as in the rural households, husbands usually control the household spending for purchases, so it becomes difficult to justify the financial savings to men because wood is obtained at zero cash and collecting it is considered as women's work. Further, many studies indicate that while cookstove is targeted as a time saving device, in practice, it has been observed that many ICS do not actually take less time to cook as compared to traditional stoves. A user can put in as much firewood in traditional stoves depending on the heat requirement whereas this is restricted in ICS for ensuring optimum fuel burning rate for high thermal efficiency. Thus instead of features such as lower consumption of fuelwood or lower time to cook, features such as ability to keep the utensils clean (which will also ensure reduced time to clean utensils) might be more useful strategy to promote ICS. Palit (2005) observes from the study of NPIC in West Bengal that the primary benefit perceived by users is cleanliness of the kitchen because of smoke removal through the chimney followed by health benefits, timesaving and lastly fuel wood savings. Similarly a recent study on forced draft metal

stove, conducted by TERI researchers in the state of Uttar Pradesh in India, reveal that less smoke followed by attractiveness of the cookstove were considered on a higher priority than scarcity of firewood for adoption of ICS. Further, many a times the health benefit of clean cooking fuels is not valued by poor beneficiaries because of lack of awareness. Electricity, on the other hand, is regarded as an aspirational demand which can also enable people the opportunity to earn more. Cleaner cooking devices, however, are considered expenditure and thus avoided.

4. Income variability of end-users

Social goods and services are targeted at the base of the pyramid population, especially those living under USD 2 per day. However, for subsistence farmers, income fluctuates with the season, with major income coming in at the end of harvest. Positioning strong marketing efforts to drive sales during this time period may be more fruitful than promotions throughout the year. In Ethiopia, the first author observed during field visits that households were procuring Mirt[1] stove (for *Injera* baking) and Rocket stoves during the harvesting season. They were, however, reluctant to procure the same when the sowing season was on as they wanted to use the limited cash to buy fertilizers and seeds for the farming. Further, the price of most ICS varies from USD 15 to around USD 70, depending on type, quality and durability of the stoves. Poor households find it difficult to raise the money for a good quality and durable ICS in the absence of affordable financing mechanisms. Wherever there are financial institutions, the very small amount of the loan does not enthuse the financial institutions to consider stove financing as a part of their usual business.

5. Limited market players and stove builders in the rural areas

There is a wide variety of stove technologies on the market today – ranging from basic ICS to advanced forced draft stoves. While there is a growing set of private actors and NGOs in the sector, the majority of them are small and have yet to scale up to meet the magnitude of the problem. Further, there are very limited number of trained technicians and stove builders in the rural areas who can build improved mud stoves and also provide the necessary post installation maintenance and these also limits the market for dissemination of ICS.

6. Knowledge gap

Another key barrier is that there is a huge data and knowledge deficit on this issue of cookstove adoption. Significant research is required in order to strengthen evidence-based action/policy if progress is going to be made in changing the trends. The role that different actors could play for enhancing ICS dissemination and the market potential for clean cooking fuels and technologies is not well understood. While the markets are naturally segmented according to income, there are many distortions in both traditional and modern fuels (Foell et al, 2011).

Recommendations and Conclusions

While there is a high potential for ICS to become an attractive opportunity and an impactful mechanism to improve health outcomes and livelihood opportunities for millions of households, energy access

[1] The Mirt (meaning 'best' in Amharic) stove originally developed in the 1990s by the then Ethiopian Rural Energy Development and Promotion Centre is designed for baking *Injera*, which is the staple food of Ethiopians. The stove is made up of mortar (sand/cement mixture) and has provision to accommodate cooking pot in addition to *Injera* baking plate.

program will be successful as long as the individual households accrue perceived and real benefits. Further the barriers are more to concern with social issues as most of the ICS programs seem to address and work on the technical design aspects of improving efficiency of ICS (both mud based and turbo stoves). Customised designs of ICS have to be developed for different regions and countries (and not "one size fits all" approach), both for fixed and portable stoves, such that they can use different types of biomass fuels and are easier to operate (for example, using the same stove for heating and smoking in cold regions). It might also be worthwhile to understand the users' perception and liking about the features (positive) of traditional stoves and attempt incorporating such features in the ICS to ensure their wider acceptability.

It will also be useful to adopt an integrated approach – an effective kitchen design with proper ventilation along with introduction of high efficiency stoves. This could be also least invasive intervention to improve indoor air quality in rural kitchens, which is also critical. Further, it is important that cookstove design takes into account compatibility with a wider variety of utensils, given diversity of foods, and also different types of flames for easier adoption of the stoves.

A key challenge, both in South Asia and Sub-Saharan Africa, will also be to ensure that the cookstove is affordable enough for the end-consumer. Novel retail and financing mechanisms including bundling using the joint liability group route should be explored to enable smaller payments over a specified period of time. Instead of conventional product sale modalities, concept sale approach might yield better results. Thus innovative and focused marketing models for reaching out to the rural population coupled with better supply chain of entrepreneurs and capacity development of youths and village women to build and service ICS is required for wider dissemination of ICS. Adequate awareness and marketing efforts is also required targeting both the gender to explain the monetary benefits of ICS in avoided fuel and health expenditure.

Box 2: Determinants for scaling up cookstoves dissemination

To address the barriers to scale up both the supply and demand for cookstoves, adequate support will be required to (i) facilitate partnerships between stakeholders, sharing of knowledge and create extensive awareness on ICS (ii) understanding of users' requirement and development of multi-fuel ICS with flame control mechanisms (iii) promoting acceptable minimum standards for stove performance, and (iv) providing and promoting a wider base and diversity of financing options available to consumers as well as the entire supply chain.

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List of photos

Figure 1: Women cooking Injera in an improved Mirt stove in Arse Negalle,

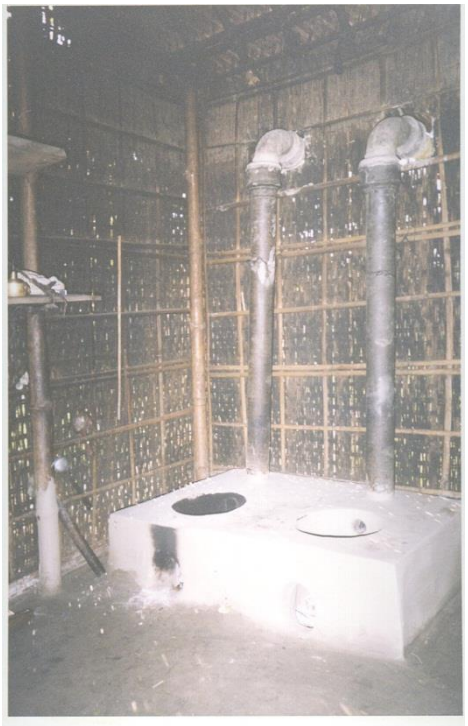

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Figure 4: ICS customized by a user in a village in Bhutan depending on the need for smoking of food items

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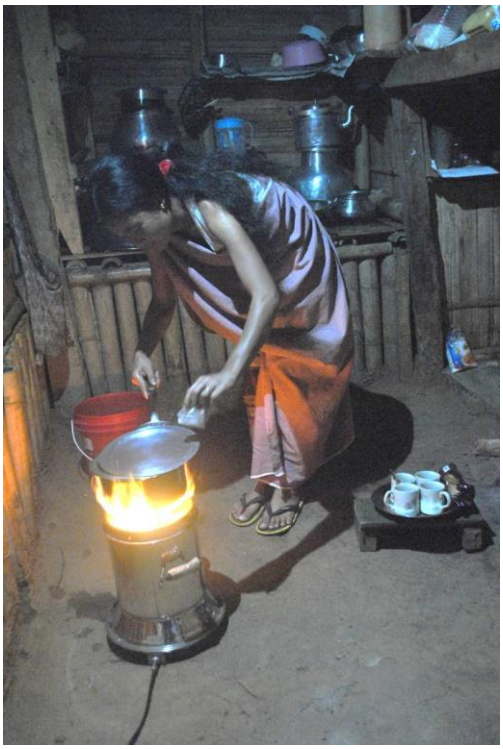

Figure 6: A user cooking food in a forced draft stove in a village in Meghalaya, India