A Field Assessment of Adoption of Improved Cookstove Practices in Yogyakarta, Indonesia: Focus on Structural Drivers

Cynthia Waszak Geary, PhD
Social and Behavioral Health Sciences
FHI 360
Durham, NC

Ciptasari Prabawanti
FHI 360
Jakarta,Indonesia

Christina Aristani
Prianti Utami
Yayasan Dian Desa
Yogyakarta, Indonesia

April 2012

FHI 360 Headquarters
2224 East NC Highway 54
Durham, NC 27713 USA
Tel: 1.919.544.7040
Fax: 1.919.544.7261

Acknowledgment
The field assessment described in this report was supported through an FHI 360 Catalyst Award, "Getting Us to the Table." The opinions expressed within the report reflect those of the authors only and not necessarily those of FHI 360.

A Field Assessment of Adoption of Improved Cookstove Practices in Yogyakarta, Indonesia: Focus on Structural Drivers

I. INTRODUCTION

Indoor air pollution (IAP) caused by burning biomass fuels in traditional cookstoves increases the mortality and morbidity risk for millions of the poorest women and children around the world. To mitigate the negative health effects of the toxins found in the smoke and soot from traditional cookstoves, engineers around the world have designed improved cookstoves (ICS) to burn biomass fuel more efficiently and/or to use other cleaner fuels at an affordable price. Designing cleaner cookstoves is only the first step, however. To realize their benefits, people must be convinced of their advantages and the feasibility of acquiring and using them correctly. The process of consumer adoption has not been as straightforward as anticipated. Most of the effort has been focused on supply-side issues, but many improved cookstove programs suffer from poor uptake. Greater understanding the social and behavioral barriers to adopting improved cookstove technology is needed to inform new program design.

As this report focuses on improved cookstove adoption, we will operationalize this term for the reader. Adoption in the broadest sense is not an "either/or" event. There is a continuum of cookstove practices that relate to consumer actions to reduce IAP. The first step is the acquisition of an improved cookstove. An improved cookstove is a stove that is more fuel efficient and releases fewer emissions than the one previously used. Usually, improved cookstoves are compared to a traditional "three-stone" fire, but they also can be compared to something more efficient than that but less efficient than the current improved cookstove. An improved cookstove may use the same kinds of fuel previously used (like wood) or something cleaner, like liquid petroleum gas (LPG). Making a change from one kind of fuel to another is adoption of cleaner fuel. In addition, there are cleaner kitchen practices promoted to reduce indoor air pollution that may be equally beneficial as improved cookstoves. Chimneys can be built and windows can be put in kitchen walls, for example. Some improved cookstoves require changes in cooking behavior to realize their benefits, such as cooking two pots of food simultaneously instead of sequentially. A final issue with cooking practices is the use of multiple fuels/stoves at one time also known as "stacking" of fuels/stoves. In many households, traditional stoves are used at the same time as improved cookstoves, or the different stoves may be used for different foods. It is not merely the household acquisition of an improved cookstove, but its correct and sustained use to the relative exclusion of less efficient stoves that is critical to improving health, though any movement toward behaviors that reduce emissions are valued. To simplify our language, we will use the word "adoption," but we are really meaning any behaviors along the continuum from acquisition to correct and sustained use in relative exclusion of less efficient stoves.

A field assessment to improve our understanding of the implementation/adoption challenges of improved cookstove program in Yogyakarta, Indonesia was conducted in February 2012. This assessment was conducted as a collaborative effort of FHI 360, an international NGO with a focus on health and development, and Yayasan Dian Desa (meaning Light of the Village

Foundation) (YDD), a well-established NGO in Indonesia with a longstanding focus on rural development, including improved cookstove programs. The assessment was conducted in two districts in Yogyakarta where Yayasan Dian Desa (YDD) has introduced improved cookstove technologies for burning wood fuel. These villages exemplify two different social contexts, different types of cookstove usage and the adoption challenges of each. One village is in a peri-urban area where stoves are used for household cooking only, and the other is in a remote, rural area where wood is used for fuel for home industry as well as household cooking. YDD's work is primarily focused on technology and supply side issues but they recognize the need to gain a better understanding of the variable adoption and sustained use results.

The assessment team was comprised of Dr. Cynthia Waszak Geary, Director of the Social and Behavioral Health Sciences department of FHI 360, Ms. Ciptasari Prabawanti, Chief of the Behavior Change unit in FHI 360's Indonesia office, Ms. Christina Aristanti, Deputy Director of Dian Desa and Ms. Prianti Utami (Tami), Head of Biomass Energy Programs, YDD. We also consulted with Mr. Mike Hatfield, the International Program Director of Aprovecho Research Center (ARC), an international NGO focused on improved cookstove technology, but he was not able to join us for the assessment.

II. SITES

Two sites were chosen in Yogyakarta for this assessment as exemplars of different cookstove uses and introduction programs. The first, *Wonokromo* village (*desa*) is in Bantul District (Pleret subdistrict). We spoke community members in Jejeran I subvillage (*dusun*). In this site, improved cookstoves to burn wood and charcoal for household use were introduced in 2004. There was widespread adoption of the stoves. In 2006 an earthquake hit, leveling the homes in the village and destroying the improved cookstoves in the process. Many homes were being rebuilt and the government began giving people LPG stoves and subsidizing LPG fuel, though some people continued to use other types of stoves as well. This village is peri-urban and its members earn income as farmers, traders, laborers, housecleaners, and preparing food.

The second site, *Hargowillis* village, is in Koulon Progo District (Kokap subdistrict). We spoke to community members in Tegiri II subvillage. People in this village use cookstoves for industrial as well as household use. The primary livelihood in this village is the harvesting and processing of palm sugar in both cake and crystal form. In 1996 and again in 2009 YDD introduced a three-hole woodstove that could be used for palm sugar processing in Koulon Progo district, but uptake in the Tegiri II subvillage had been very poor. YDD did not know why adoption was so much weaker there than in other similar villages in the district and wanted to explore this through this field assessment. This village is very remote and high up into the mountains near Yogyakarta. Their economy is much more agriculturally and less cash-based than Wonokromo. Most residents are subsistence farmers.

Figure 1. Map of Bantul district

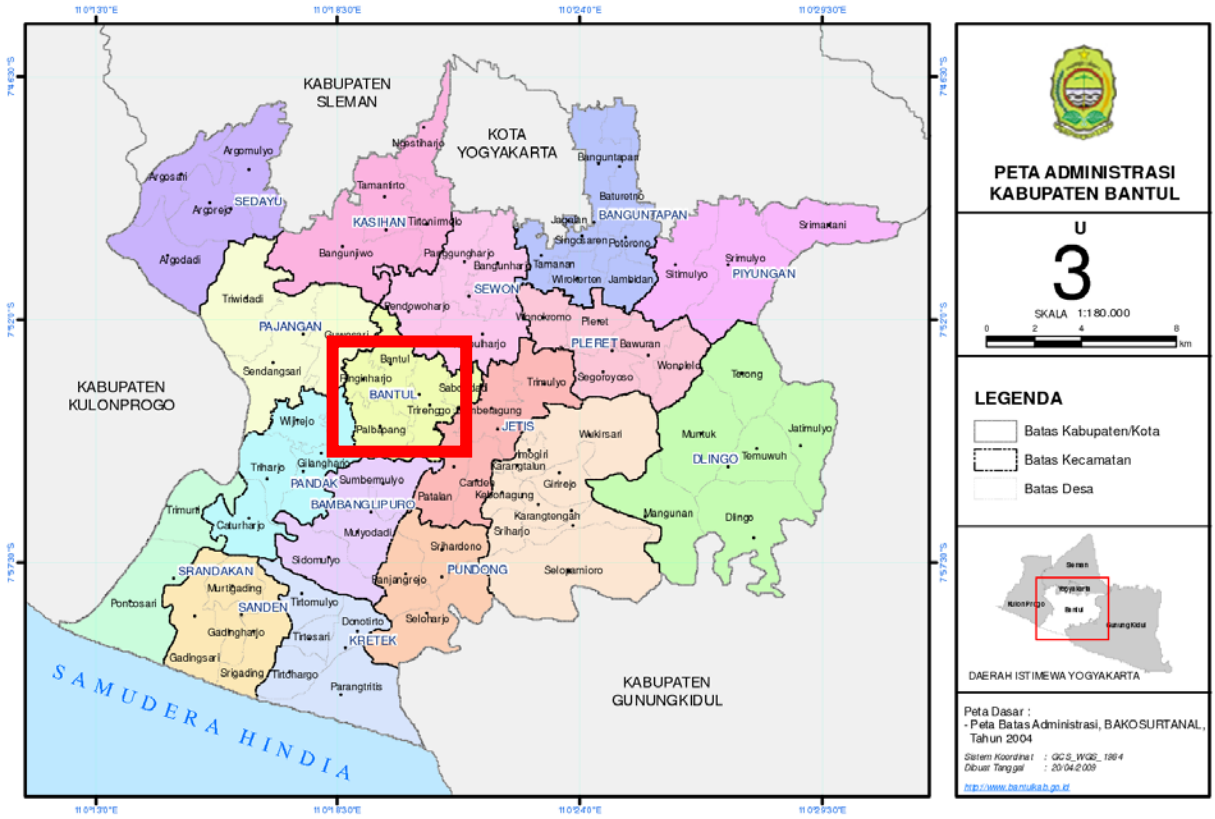

Figure 2. Map of Koulon Progo district

III. IMPROVED COOKSTOVE DESIGNS

The improved cookstove design introduced in the Bantul district is a two-hole terra cotta wood-burning stove for household use only (Figure 3). The increased efficiency of this stove derives from a baffle that forces heat from the fire under the first hole to under the second hole. This allows for two pots of food to be cooked at one time with the same amount of wood typically needed for only one pot. To realize the energy savings from this stove, the cook must prepare two pots of food at once which requires some advance planning and is a change in cooking practice for most women.

The introduction process for this cookstove encompasses several related activities. Meetings are held with influential groups within the targeted villages. These meetings introduce the technology. In addition, potential stove producers are taught how to make the liners for this type of stove. It is relatively light and can be transported easily. Chimneys can be attached for ventilation.

Figure 3. Improved two-hole wood burning stove

The second design is a three-hole cookstove (Figure 4a) which could be used for household cooking as well as for home industry – the cooking of sap from palm trees to produce palm sugar in either cake or crystal form. This stove is an improvement over the traditional stove because the grate below the hole and the baffle under the second and third hole maximizes the heat transfer with additional air and allows enough heat for pots to cook food in the second and third holes, removing the need for fires under them and reducing the wood needed.

Community members are introduced to the improved technology and producers are taught how to make the liners for the stove (shown below), while consumers are taught how to make the concrete housing for the liners and how to attach a chimney using locally available materials. Community members are usually reached through trade associations such as the palm sugar producers association.

Figure 4a.Three-hole wood burning cookstove.

Figure 4b. Liners for three-hole woodburning cookstove.

In addition to improved woodburning stoves there are have been improved one-hole charcoal burning stoves introduced and produced in this area (Figure 5). Often the same producers make the two-hole wood stove and the charcoal stoves. The improvement in the charcoal stove results from a greater number of holes in the grate from 6 or 7 to 31 and the metal or concrete encasing with a layer of rice husk ash as insulation that keeps the heat from dispersing.

Figure 5. Improved charcoal stoves

IV. FRAMEWORK FOR EVALUATING THE EFFECTS OF SOCIAL DRIVERS ON IMPROVED COOKSTOVE ADOPTION FOR HEALTH AND NON-BENEFITS

To design an effective ICS introduction program, it is necessary to understand the mechanisms through which the program would influence a change in behavior – namely increased ICS adoption. A conceptual framework was developed to describe the mechanisms that we believe are key to this process.

The assumption behind this framework is that increased adoption of ICS will lead to reduced exposure to IAP, and this will lead to improved health outcomes. Our focus is on increasing ICS adoption and thus we seek to increase our understanding of the influences or 'drivers' of adoption. Influenced by social scientists studying other behaviorally driven health issues such as HIV and obesity (Auerbach, Parkhurst & Caceres, 2011; Glass and McAttee, 2006), we have chosen to shift our target of intervention from the individual (which has not worked well in the past) to modification of social conditions that drive these behaviors. "Social drivers" have been defined as "core social processes and arrangements – reflective of social and cultural norms, values, networks, structures and institutions – that operate around and in concert with individuals, behaviors and practices" to influence what "humans do, think and desire," – in this case, adopt ICS (Auerbach, et al., 2011, p. 3).

It is the job of social scientists (to paraphrase Auberbach et al) "to unpack the social drivers and social arrangements…to better understand how they operate in concert with [cookstove adoption], dynamics at the individual, [family] and social network levels in 'particular social contexts' and then to determine how they can best be modified for [cookstove adoption] purposes." Social drivers work at multiple levels of social organization. It is necessary to understand social drivers that work at the level of program implementation. We focused our framework and our assessment on the community (village) level because ICS programs in general and Dian Desa in particular. We make recommendations for future research and program to be focused on that level as well.

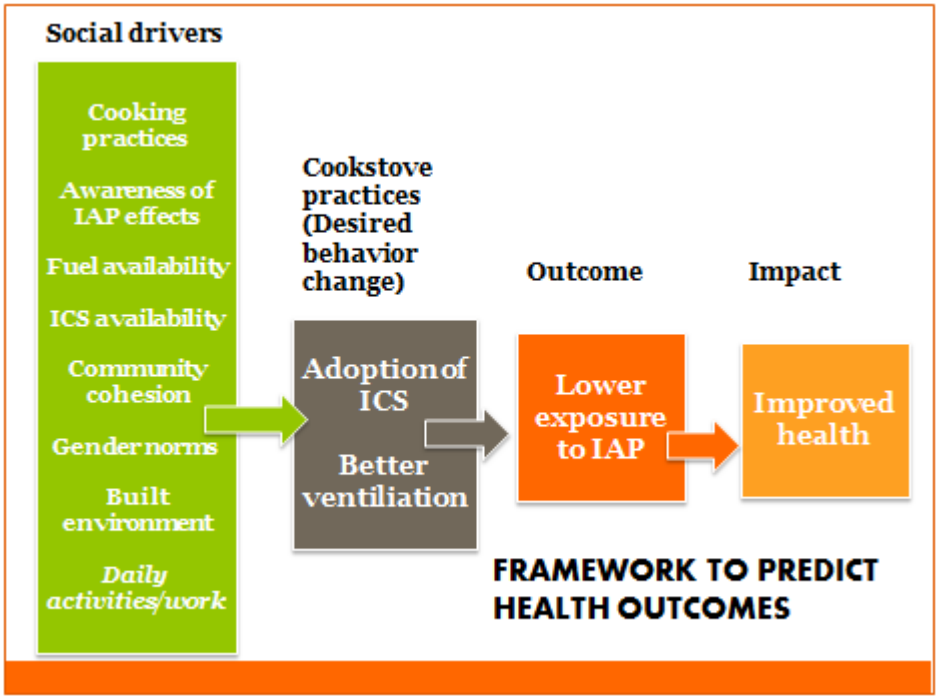

Figure 5a. Predicting health outcomes

Social drivers of ICS adoption. In Figure 1, 8 social drivers are identified, based on previous research on this topic. These are: cooking practices, community awareness of IAP dangers /efficiency of stove use; fuel availability; ICS availability; community cohesiveness or efficacy, built environment; and structure of work/daily activities.

1. *Cooking and food practices and perception*. This refers to the ways in which cookstoves are used, the kinds of food that are prepared by community members, when the stoves are used, when meals are served and to and by whom. Cooking practices may have an impact on whether a particular cookstove design is useful and they will also determine how much of the day a fire is needed and where and may suggest either relevant communications about overcoming seeming barriers to using certain kinds of cookstoves or in the design or modification of a new stove itself.
2. *Awareness of dangers of IAP*. There is evidence that many families who burn biomass for cooking and heating do not understand the health dangers related to inhaling the soot that it generates and/or do not believe that reducing it will outweigh some of its benefits (e.g., mosquito reduction). Questions of interest include: What are the perceptions of maternal and child mortality and morbidity within the village? What exactly do community members believe about the health dangers of IAP? Are there concerns about smoke and upper respiratory infection? Does this differ by sex or age? Do they believe there are any benefits of smoke in their houses?
3. *Availability and cost of fuel*. People will be more or less motivated to maintain or switch their current cooking practices depending on the availability and cost of various types of

fuel. For example, if wood is plentiful and free, there would be less incentive to switch to LPG, even with government subsidies. On the other hand, a fuel that costs a little more money might be seen as a better alternative if it frees up cooking time for other income-generating pursuits.

4. *Knowledge about and availability of improved cookstoves*. This refers to whether there are improved cookstoves for sale within the community, how much they cost (whether they are affordable) and logistical requirements for obtaining or installing new cookstoves (e.g., transportation for delivery).
5. *Gender norms*. The understandings within communities about the differences in how females and males are supposed to act and to be treated can affect who is in the kitchen and exposed to IAP, who collects or purchases fuel for cooking and heating, who gets medical attention when children and adults have respiratory illness, the consequences for the person who cooks if food does not meet expectations, who makes decisions about cookstove practices (including decisions to purchase an improved cookstove), whether or not women are involved in the design, manufacture and selling of improved cookstoves.
6. *Community (collective) efficacy/cohesiveness*. This refers to characteristics of the community that may facilitate (or hinder) mobilization toward social change. Includes here is information on the opinion leaders in the community, the degree of networking among different social and family groups, how quickly information is communicated throughout the community, how much good will there is among different groups and/or division among them. This information can provide insight into the ways in which new information can be disseminated and by whom when designing an intervention. [social learning]
7. *The built environment*. This refers to the physical arrangement of space within households and households within the community – especially as it relates to cooking practices, exposure to IAP and communication networks within communities.
8. *Structure of work/Daily activitie*s. It is important to understand how cooking fits in with other daily activities and how changes in cooking behavior would facilitate or disrupt their work during the day.

Desired behavior change: adoption of improved cookstove practices. These social drivers are thought to influence cookstove practices in various ways alluded to above. The primary practice of interest has been the acquisition and use of improved cookstoves. In some cases this may mean shifts to incrementally more efficient woodburning cookstoves or a switch to a cleaner fuel such as natural gas/LPG. Other behavioral practices can help reduce exposure to indoor air pollution as well, such as keeping children away from the stove and the smoke, putting windows in the kitchen and building chimneys. Moving a stove outdoors in a warm climate may be another possible solution in some contexts. An intervention could be designed to promote all of these, but would find a focus presumably based on what is learned about the household situation of community members.

To evaluate an intervention to reduce IAP, we would need to measure adoption of cleaner cookstoves practices such as improved cookstove adoption and the effect of these practices on

exposure to IAP within the household. It has been noted by Ruiz-Mercado and her colleagues (2011) that measurement of adoption can be complicated by the fact that people rarely make a complete change from using one cookstove to another or from one fuel to another, often using multiple stoves and fuels to meet cooking needs. Thus, understanding cooking practices that might foster or mitigate IAP requires understanding the amount of time any of the household's cooking options might be in use and the relevant efficiency of each. Measuring use of multiple stoves is now possible through the use of sensors to measure heat output from various appliances, though their use is relatively new.

Health-related outcome and impact. Potential reductions in toxins from smoke and soot and reductions in fuel burned also could be determined by tests of efficiency of the stoves in any household in relationship to the amount of time various stoves are used. IAP can be measured within the household using HOBO and UCB-PATS instruments. The final outcome of interest is improved health outcomes, but this is a longer term outcome and probably would not be possible to demonstrate within usual evaluation periods. In the field assessment we sought to understand people's perceptions of their health problems, but in any evaluation we would also collect these data in a systematic way so that we can measure health outcomes even if we are not using this as the main indicator.

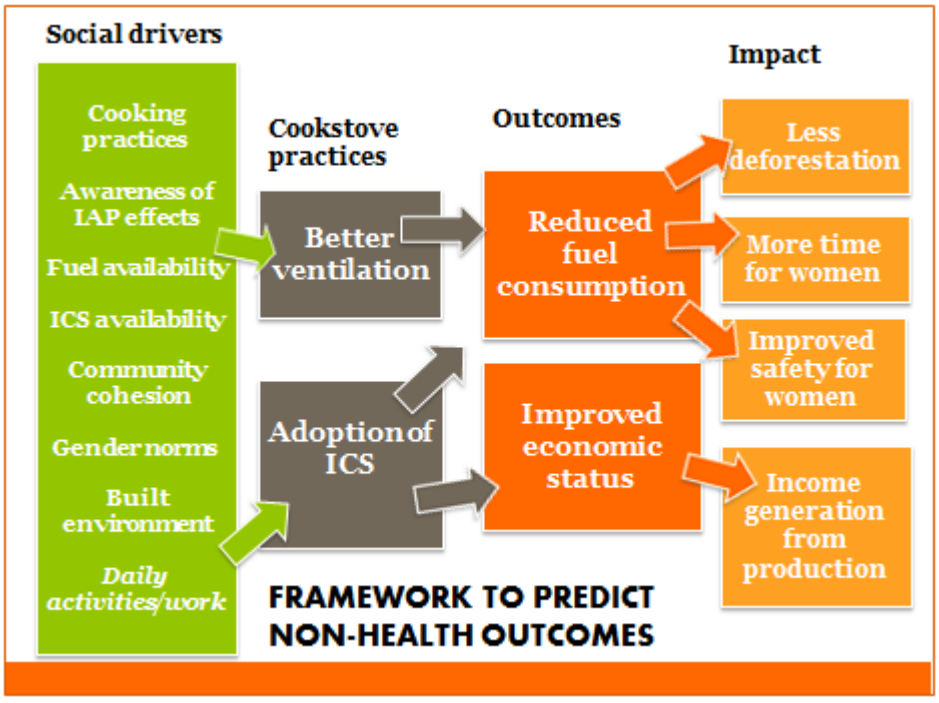

Figure 2. Predicting non-health outcomes

Non-health benefits of improved cookstove practices

In this framework (Figure 2) we are looking at the same structural drivers, but a different set of outcomes related to the adoption of improved cookstove practices. To the degree that multiple positive outcomes for a particular intervention can be documented, the stronger the argument

for funding of the intervention and evaluation. The two non-health outcomes we collected information on included:

1. *Reduced fuel consumption*. Improved cookstoves more efficiently burn biomass (or use some other kind of fuel altogether) and reduce the need for gathering wood. Less use of wood leads to less deforestation. Where women have to go out far from their homes to gather wood, their safety is often an issue. We need more information about the extent to which these are issues in the villages where we will be doing the assessment. What kinds of biomass are used? How much is needed every day? How much time is spent gathering firewood? Who gathers firewood? How plentiful is it? If it is women who gather it, how safe are they? How would gathering less firewood affect their lives? How would having more plentiful firewood change their lives?
2. *Economic benefits*. Cookstoves are used by some for home industries and thus have a direct effect on household income, as does the cost of fuel (if that is an issue). The manufacture of improved cookstoves can lead to economic development for individuals and communities where they are located -- and for women within those communities if they are able to participate in this venture. YDD's philosophy is to make development sustainable by giving people the technology to produce their own cookstove production within the areas YDD serves. Though they provide some subsidies and access to credit through the cookstove producers, their programs are designed to be economically viable within current market conditions. To what extent this has happened is important to determine.

V. RESULTS

The assessment results are organized by social drivers of cookstove practices described by the conceptual framework.

Cooking practices

In Wonokrono, improved cookstoves were introduced in 2004 and many women were using them. An earthquake struck in 2006, causing serious damage to the entire village and most of their cookstoves were broken, including the improved ones. At the same time that many houses were being rebuilt, the government was giving away free gas stoves and subsidizing liquid petroleum gas (LPG). The younger women we met with said that they preferred using the new gas stoves because their food cooked more quickly and the kitchen was cleaner, which is important to them in their new homes. Many of these women earn at least some income for the family so time is important to them. Also, new homes tend to be smaller and the gas stoves take up less room than wood stoves. They said they do use wood stoves when they have to cook a lot of food, but most of the time they only use the gas stoves and their husbands do not object. They also said they would be willing to pay higher prices for gas once the subsidy has ended. Some said they had initially been afraid to use the gas stove, but after some experience with them, they are no longer concerned about safety with the gas stoves. A couple were using improved wood cookstoves though not all of them. Older women, however, were continuing to use their wood cookstoves much more than the younger women. Most older women also had a new gas stove, but used it less. For most of these women, they cooked most of their food early

in the day using wood fuel – usually for about an hour – and then might use their gas stoves later in the day to re-heat the food they had cooked earlier. The foods usually cooked include: rice, tempeh (tofu), fish, chicken and sometime beef.

In Hargowillis, cookstoves are used for household and (home) industrial purposes: to cook the family's food and the sap of palm sugar into palm sugar cakes or crystals for income. Thus, their stoves are burning wood for up to seven hours a day and a lot of heat is needed. Their traditional stoves have three holes with fire burning under each hole. Usually they do not use chimneys. The current improved cookstove design includes a baffle under the back two holes so that the fire stays under the first hole (where the palm sugar is cooking) and heat is forced back under the last two holes, with less wood needed for the same amount of heat. This takes a little longer to get started but actually provides as much heat. There were complaints that the improved stoves did not allow the use of heavy logs that would burn longer without needed to add more fuel.

There is also a perception that chimneys slow the process of combustion and cause less heat. This perception is not borne out by performance testing and seems to be related to people's concern that there is no fire under two of the holes. There is an expectation that a fire is needed under each hole and without that the stove is not effective. This is a perception that needs addressing, probably needing several types of communication, including a side-by-side public demonstration.

In contrast to the experience of Hargowillis, however, is the experience in Sidoharjo, another village in which palm sugar is processed at home. After hearing about the improved cookstoves, women in one RT (unit within a village made up of 30-50 households) decided to find out more about them as a group. Afterwards, the entire group decided to switch to the new cookstoves, enlisting the help of YDD to purchase the liners and their husbands to transport the liners and construct the housing and chimneys after attending workshops by YDD. This particular group has been in the forefront of adoption in the subdistrict and one couple in particular has served as unofficial promoters – allowing people from other villages to see their improved cookstove. This husband and other husbands in the village get hired to help build the stove housing for others who can't or don't want to construct themselves – earning additional income for his services. The wife said that it often takes a lot of communication for others to understand how to construct and use the cookstoves and she is happy to provide this information to others.

The most common complaint about traditional cookstoves is the amount of smoke and soot and the way it makes everything dirty in the kitchen and the rest of the house, and people readily acknowledge that the improved cookstoves are effective in keeping the walls cleaner.

Analysis

- Consumer needs are very different between household cooking only and household and industrial cooking.
- Consumers need to understand the mechanics of cookstove improvements and see the two kinds working side by side to really belief that the new one works as well as the old one. Of particular importance is an understanding that the lack of fire under one or more of the holes does not result in lower heat.
- A change to the improved cookstoves requires a change in cooking behavior in that more foods should be prepared at one time instead of sequentially.
- Promotion of improved cookstoves is not a one-time activity. It requires extensive discussion and follow-up.
- Adoption is facilitated by community-based learning and action.

Awareness of health effects of IAP

The promotion of improved cookstoves in Indonesia has focused primarily on reduction in fuel needs and hygiene and not on health benefits.This was evident at all levels in people's lack of awareness of the linkages between exposure to IAP and respiratory and other illnesses. At the village level, community members seemed not to have ever considered whether black smoke and soot emanating from their stoves was related to their respiratory ailments. They all reported that respiratory infections were a problem but did not realize the association. When those who had done something to improve ventilation were asked about how they felt with less smoke in the house they admitted that it was easier to breathe and they felt better, but had not really thought about it until they were asked. Some people also mentioned that smoke irritates their eyes. They said no doctors had ever mentioned this to them and said if they had been aware, an improved cookstove might have seemed more important. The older women in Wonokrono asked what some of the problems related to smoke were. They associated respiratory illnesses to certain seasons and not to smoke. They said that neither burns nor eye irritations were a problem in their households.

At the sub-district health post, the doctor there showed us 2011 statistics that nearly 10 percent of their catchment area population had been to the clinic during the year for some sort of respiratory ailment. The sanitation officers visit every household during the year to look for health conditions and included in that is documentation of a "ventilation window." Only 25 households in that sub-district (around 600 households) had such a window. Despite this documentation, it did not seem that there had ever been any education about this. The doctor himself said that it made sense that smoke contributes to respiratory illness but he had never thought about this but perhaps he should.

People from the district MOH offices saw their role in reduction of IAP related to the documentation of ventilation windows by the sub-district sanitation officers. They were interested in thinking about how they could participate in a multi-sectoral approach at the district level with the Ministry of Energy and Mineral Resources (MOEMR) and Ministry of Social

Welfare (MOSW) to address the issue. (Interestingly, many people at the district levels thought everyone had converted to gas because of the subsidies and no one burned wood.)

At the level of central Ministry of Health (MOH), we learned that there currently is a program that might provide some policy support related to improved cookstove promotion – the Practical Approach to Lung Health (PAL). This is a WHO program that is being pilot tested in West Java, Lampung and Jakarta. Currently TB cases often are misdiagnosed as more general respiratory illnesses, missing the opportunity to correctly treat them. The goal of PAL is to provide specific diagnoses for various respiratory illnesses to ensure effective treatment. Though smoke does not cause TB, it might trigger latent cases and there might be some useful linkages between this program and IAP reduction programs. This will require more follow up from YDD and FHI 360/Indonesia. Currently there are not interventions focusing on improved cookstoves specifically from the MOH, but a general awareness that their promotion would have health benefits. Doctors are considered credible sources of health information among residents of both villages making them an important source of influence related to adoption of cleaner technologies.

Improved cookstove programs have been part of the MOEMR work (off and on) over the past couple of decades, so YDD has a strong relationship with them. They have not framed improved cookstove usage as a health issue, but rather an environmental one. The Director of Biomass Energy was supportive of promoting use as a health issue and is interested in interventions that might do so.

Analysis

- Efforts to increase improved cookstove uptake need to include education on the health effects of IAP to policymakers, health providers and community leaders and members.
- Health providers at the sub-district and district levels are trusted sources of information to community members and would be a credible source of information about the health benefits of cleaner cooking practices.
- The tracking of household ventilation by sanitarians could be an opportunity for providing targeted information on the effects of smoke and referral to cookstove programs.

Availability and cost of fuel

Wood fuel is used by 42% of households in Yogyakarta – though there is considerable variation by district. Wood is the fuel used by most villagers in Hargowillis and is in plentiful supply. Most wood is gathered from one's own "yard," but often it is supplemented by purchased wood. Women who use traditional cookstoves collect wood three times a week. Generally they cut branches off trees. The leaves are removed to feed livestock (goats) and the remaining limbs are brought to the house for firewood. During the rainy season it is more likely that a family would buy wood because of the time it takes to dry wood out. A bundle of wood costs about Rp 23.000 rupiah and lasts about 15 days. We heard it said over and over again by community members and leaders that wood is plentiful and free and there is no reason for most people to change fuel types.

In Wonokromo, most people gathered wood from their own yards and did not feel that it was in short supply. Many also use gas – also not in short supply and subsidized by the governments so not terribly expensive. Three kilograms cost about 15,000 rupiah and last about a week in a household. (The unsubsidized cost is Rp 75.000/12 kg).

Analysis

- It is unlikely that people living in remote villages – especially those needing more fuel for palm sugar processing – are going to change from wood to gas. Thus, improved woodstoves continue to be important for them. We should not assume they are going to change to gas any time soon, and certainly not for the majority of their cooking. There is a perception outside of these geographic areas, however, that everyone in the country has changed to gas, so the issue is not well-understood within the more educated, urban populations.

Availability of improved cookstoves (production and distribution)

It is an important feature of the YDD cookstove program that they do not give cookstoves away, but train small business owners to make them to generate income, but still at an affordable cost to the consumer. Improved cookstoves have been introduced in all the villages where we visited. Generally, the technology for the cookstoves is introduced and "producers" who can manufacture the cookstoves or the cookstove liners are trained to do so. Often these are people already producing other terra cotta goods, such as tiles. At the beginning YDD provided revolving fund to be used by community in the Kokap Sub-district. A cooperative of palm sugar at the district level then adopted the credit scheme and provided credit to their members who are interested to have the improved stove. Different producers make different kinds of cookstoves.

Cookstove producers sell their products to several sellers who sell it to people in the village. Sometimes there are distributors or "middle men" who buy directly from the producers and then sell to the sellers. Market forces affect the production of improved cookstoves. It is important that producers obtain the greatest margin for their goods in comparison to other goods, such as tiles. We heard that one group of producers was only producing improved cookstoves "on order" because they were making more money producing small ornaments, which require less clay and show a greater profit. If supply is low, those who might want a cookstove will not be able get one, but if demand is low, producers will not be interested in producing them.

It is up to individuals to purchase the liners/stoves and if necessary build the housing for the cookstove. Similarly, community members who want a chimney with their current or new stove would be given information about its construction but expected to build it themselves. This is not seen as a barrier as most people in the village have masonry skills. One related issue of concern is transportation. The villages we visited are remote and in the hills, making delivery of improved cookstoves difficult. The palm sugar stove liners, especially, are heavy and require a

truck. One solution is for several villagers to buy at one time and share the transportation expenses.

It seems that community members in Hargowillis Village knew where to buy improved cookstove liners, but what they were lacking was information about the benefits of improved cookstoves relative to other cookstoves. They felt that other groups in the village had been singled out for that information but they were not included. This will be discussed in more detail under "community cohesion/communication networks."

The cost of a stove for palm sugar cooking is about $20 to $24 including all costs. Availability of credit was another issue raised by men in Hargowillis, but the women in the same village described their own savings club, which seemed to be a possible vehicle for small loans for cookstoves. Another relevant issue raised by women in Hargowillis was the concern about taking business away from the traditional cookstove seller in the village. It seems that she should be included in any plans for distribution of improved cookstoves.

In Wonokromo, some women seemed to know where the improved cookstoves could be purchased, but others did not. During our meeting, one woman offered that she had several for sale.

Analysis

- Consider the livelihood of traditional cookstove sellers and include them in plans for selling improved cookstoves
- Information about the availability of improved cookstoves should be disseminated proactively and widely within villages and districts – not assuming people will share this information themselves.
- Sustainability of improved cookstove uptake is encouraged by the use of local producers and the need for consumers to buy their own. Creative credit mechanisms will help sustain this model.

Gender

Gender was a greater factor in improved cookstove adoption among the households where they are used for home industry as well as household use. Where they are only used for household cooking, men seem less involved than when they are used to produce income.
In Hargowillis where palm sugar is processed, there is an accepted division of labor related to fuel gathering, cooking and cookstove use. Women gather the wood (though men say they sometimes do) and do the cooking of the household food and the palm sugar. Women often go together to get the firewood. Men work in the fields and harvest the palm sap. Women package and sell the sap to the "middle men." When a new stove is needed (improved or otherwise), women talk to their husbands about it (though it is generally obvious) and the men make the purchase and arrange to get it delivered. When a chimney is added, it is probably the woman who asks for it but the husband who builds it.

In Hargowillis about half the women said they had additional income generating activities outside the house and half said they only did household work. In all sites, decisions about household food consumption and cooking were generally left up to women. In Wonokromo, there was more opportunity for women to earn money outside the house. Younger women are more interested in switching to gas for cooking, and men seemed to be going along with their decisions to do so, especially because it freed the women up to earn other income.

With regard to health effects, the subdistrict health posts, the data given us was not disaggregated by sex or age, though apparently, it could be reported this way. Neither men nor women suggested that respiratory problems were a reason for concern or that they thought smoke was a cause. Interestingly, most men in both villages are heavy cigarette smokers – smoking unfiltered cigarettes in the house – contributing to IAP as well. Perhaps there are some possibilities for integrating messages about smoking and cookstoves as related to lung health. (There seems to be little anti-smoking messaging in the country, however, and very aggressive advertisement by cigarette manufacturers.)

Analysis

- Relevant health data should be reported by sex and age.
- Men are an important target group for communication relevant to improved cookstove adoption – especially where cookstoves are integrally linked to household income. They tend to focus more on the technical aspects and that may be a good "hook." The men we talked to, however, were also interested in the health effects, having never really considered them before. So, there should also be messaging for men related to health effects of IAP.
- There might be an opportunity for integrating IAP messaging for men with health messages about cigarettes.

Community cohesion/collective efficacy/social structure

Community cohesion within villages in Indonesia is facilitated by formal and informal social structures. There is a formal administrative government structure: province, district, sub-district, village, sub-village, RW (30 to 50 households) and RT (10-20 households). Each of these units has an elected head that has substantial influence on those within the unit. There are also organizations related to vocation, such as a farmers union. There were three in Hargowillis. (Out of the three groups one is a 'women only' group named "Giriloji" the other two are mixed sex.) There are also groups specific to women related to social welfare which was organized at all levels, usually headed by the wife of the unit head.

In some villages there seems to be a natural cohesion among all of its members and various groups. In Hargowillis, however, this was not so and seemed to be at the root of why there had been little uptake of improved cookstoves. The improved stove introduction had actually been done through the district palm sugar cooperative called "Jatirogo". Then the cooperative arranged for their members to come to be trained by YDD and both men and women from different villages and subdistricts and also from various groups participated in the training. Unfortunately those who participated in the training from Hargowilis belonged to only one of

the existing local palm sugar producers group and they did not share information with others. Therefore the other two groups felt ignored by the program and felt that there was a social barrier between themselves and the other group that they could not cross. They kept their resentment to themselves until they were asked during the course of this assessment about why they had not adopted the new cookstoves. They said they did not know much about them and thought they must not be for them if YDD did not talk to them about it. YDD had assumed that the people they introduced the cookstove to would have discussed them with everyone and any cookstove acquisition information would be shared with everyone as that is what had happened in other villages. Not so – to the disappointment of YDD staff.

Our stakeholder meeting with men's group of non-adopters became an impromptu information session to teach about a dozen men about the technical aspects of improved cookstove for palm sugar production. By the end of the session, all the men were enthusiastic about the new cookstoves and had started discussing credit schemes for acquiring one.

One additional observation was that in the villages where there were higher rates of adoption and use there were charismatic people who became cookstove champions. They were willing to provide time and access to their homes to demonstrate the cookstove and were highly influential.

Analysis

- It might be best to introduce new cookstoves at an administrative level higher than the village to ensure that all people feel included and then ensure that there are demonstrations with all relevant subgroups. One scenario might be to introduce the health benefits of new cookstoves within the subdistrict health clinics (with doctors as credible sources of information about health effects) and then to have stove demonstrations with all relevant subgroups.
- The identification of promoters who are charismatic and enthusiastic about the cookstoves and are influential in their communities is a critical aspect of adoption and use.

Physical structures/the built environment

In Hargowillis, the stove is in a separate "room" from the rest of the house, usually on the end of the house, though smoke seeps back into the rest of the house. Very few houses had a ventilation window or a chimney. Children did not seem to spend much time in the kitchen area and often women would move in and out of this room, tending to other chores and checking on the fires intermittently.

In Wonokromo, the 2006 earthquake had leveled all the buildings in the village and required the rebuilding of all houses. Though the kitchens seemed to be the last room to be built, this seems to offer an opportunity for promoting clean kitchen practices.

Analysis

- An easy first step for many households would be the opening up of a ventilation window in the ceiling or the installation of a chimney.

Structure of work/daily activities

In Hargowillis, the cooking of palm sap was the focus of women's work. They did not necessarily stay in the kitchen all day but had to be near enough to make sure the fire was going for hours at a time. Their household cooking was scheduled at the same time as the sap cooking. Women there also had other chores during the day, tending to children and animals and gathering firewood that took place outside of the kitchen, but often not far from it.

In Wonokromo, younger women were likely to work outside the home, limiting the time they had to spend in the kitchen for cooking. Work for pay was beginning to take precedent over household work, including cooking. This was less true for older women, who were more likely to be cooking two or three meals a day for their families. The need to cook large quantities of food for special events required the use of wood stoves rather than gas stoves.

Analysis

- Cooking practices were intertwined with the work done by women during the day and differed by the degree to which women had opportunities for work for pay outside the home.

Non-health outcomes

Because of the abundance of wood available in most places, especially Hargowillis, deforestation was not a motivating factor related to improved cookstove use. Women's safety while collecting firewood was never brought up as an issue, though in some places, women's time to collect firewood was, as well as the advantages of less cooking time in Wonokromo, where younger women were more likely to be earning income outside the home and to be using natural gas for some cooking chores.

With regard to the economic benefits related to improved cookstove use, improved status of women seemed to be a *driver* of improved cookstove use rather than an outcome in most places. Where women might be able to earn additional income outside of the home, they were more likely to want to use technology that would allow for quicker food preparation. Women were involved in some cookstove production, though not exclusively so. The economic benefits seemed to be family-owned. We heard of one family in which the husband had been able to earn additional money for the family because of his expertise building the housing around the 3-hole palm sugar stove and in the maintenance of those stoves.

The use of wood was not an economic burden in most places. Where LPG was being subsidized and where younger people were converting to its use, its cost was not considered an issue; when asked if they would pay higher prices if the subsidy was removed, community members often said yes.

VI. RECOMMENDATIONS FOR INTERVENTIONS

The following results are relevant to designing an intervention to increase improved cookstove adoption and decrease IAP:

- Social drivers of improved cookstove adoption vary by peri-urban vs rural areas and the specific use of the cookstoves (household use only vs. household and home industry)
- In remote rural areas, wood is plentiful and it is unlikely people are going to stop using wood as fuel any time soon. Improved woodstoves need to continue to be an option.
- In peri-urban areas, people are changing to gas more quickly. It is widely available and people are more likely to have "outside" jobs – meaning more cash and less time.
- Young adults are more likely to adopt cleaner fuels than older adults.
- Even those adopting gas still use wood stoves for some foods and use wood when there is a need to cook a lot of food at one time.
- Men have more input into cookstove decisions and acquisition when they are being used for home industry.
- Market forces affect producers' willingness to make cookstoves, and thus affect supply.
- People sometimes distrust the improved woodstoves because the fire is not directly underneath the pot for all holes. This was especially true for stoves that cook household food and palm sap.
- Public demonstration of the effectiveness of improved stoves is important. Follow up with consumers after their purchases to make sure they understand that the new stove is being used correctly is also important. More follow up make be needed than has been provided in the past.
- There has been little discussion of the health hazards of IAP and how cookstoves can mitigate this. There is interest in this discussion now among policymakers and community members that might open up opportunities for advocacy and funding through MOH types of activities.
- Some communication channels are more effective than others for disseminating information about improved woodstoves and health effects of IAP. Health providers should be given information and made part of any intervention to raise awareness at the community level.
- Highly cohesive communities and charismatic/well-connected promoters facilitate quick adoption and use.
- There is an interest at the district level for a multi-sectoral response to the issue of IAP. This would be strengthened by advocacy at the central government level. Any intervention to increase improved cookstove adoption should be designed with input and buy-in from district officers from the health, energy, environment and social welfare sectors.

It is clear from these assessment findings that the adoption of cleaner cooking fuel technologies is driven by a number of inter-related factors that vary by social and economic contexts. There would be no "one size fits all" intervention, but rather there are some principles that would inform interventions tailored to specific sites.

Population-based household data are needed to map current cooking practices and perceptions related to fuel, stoves and health that could be used to tailor communication messages *and* as a baseline to measure the success of any intervention efforts. Because it is unlikely that people will stop using wood as fuel any time soon, interventions should be looking at the adoption of any "step up" to cleaner, healthy cooking practices as the outcome of interest rather than defining it as a switch to gas, for example. At the same time, we would also want to measure baseline IAP levels (to be correlated with baseline cookstove practices) which can then be re-measured post-intervention.

Any intervention to promote adoption at the village level will necessarily require engaging all levels of government involvement. This will facilitate implementation and increase the likelihood of success if it is considered to be government-sanctioned. The administrative structure and community organizations provide potentially efficient channels of communication – though it will be important to understand informal channels as well. Communication networks at the community (village) level seem to be critical for the dissemination of information and persuasion. Interventions to increase adoption and correct use of improved cookstoves must be designed to ensure community cohesion and promote collective efficacy with regard to utilization of improved cookstoves. A social learning approach in which communication is delivered to the community as a whole and community members can reinforce relevant learning seems especially appropriate. Information about formal and informal communication networks within and between villages should be investigated through the initial baseline data collection.

A focus on health-related outcomes will be new in Indonesia cookstove programs, but one that will provide additional motivation for adoption of cleaner, more efficient cookstoves.

VII. RECOMMENDATIONS FOR EVALUATION

The data collected to help design an intervention should also serve as baseline data for it evaluation. It will be essential to collect data on all possible social drivers to gain a better understanding of how an intervention might or might not need to be adapted for specific contexts. Though there may be one or two designs of household cooking stoves acceptable across Indonesia (this is less true for stoves for industrial purposes), any intervention to promote adoption will need to take local needs and circumstances in account in the design. Thus, there will be no one adoption intervention design that can be scaled up across Indonesia – the cultural differences across the country are too great – even as we have seen within the Yogyakarta – for that to be effective. While there probably are core messages that are critical in all circumstances, how they are delivered and through whom will be important. We can add to the knowledge base, however, about what drivers are most important to particular context and how those might be modified to achieve results.

References

Auerbach, Parkhurst, Caceres (2011). Addressing social drivers of HIV/AIDS for the long-term response: Conceptual and methodological considerations.*Global Public Health,* DOI: 10.1080/17441692.2011.594451.

Glass, T. and McAtee, (2006).Behavioral science at the crossroads in public health:Extending horizons, envisioning the future. *Social Science & Medicine, 62,* 1650–1671.

Papa, M., Singhal, A., Law, S.,Pant, S., Sood, S., Rogers, E. &Shefner-Rogers, C. (2000). Entertainment-education and social change: an analysis of parasocial interaction, social learning, collective efficacy and paradoxical communication. *Journal of Communication, 50,* 31-55.

Ruiz-Mercado, I. (2011). Adoption and sustained use of improved cookstoves. *Energy Policy 39:* 7557-7566.