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MA Quaiyum Sarkar  
Nasima Akter  
Mizanur Rahman

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Nasima Akter  
Mizanur Rahman**

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**Research and Evaluation Division**  
BRAC Centre, 75 Mohakhali, Dhaka 1212, Bangladesh  
E-mail: [research@brac.net](mailto:research@brac.net), Web: [www.brac.net/research](http://www.brac.net/research)  
Telephone: 880-2-9881265, 8824180-87

For more details about the report please contact: [maqs1965@yahoo.com](mailto:maqs1965@yahoo.com)

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## ABSTRACT

There are different models of Improved Cook Stove (ICS) being used in Bangladesh. This study attempted to know which type of ICS people accepted more. Specific objectives were to know i. what fuels are being used in improved cook stove; ii. what types of ICS are being used and preferred; iii. the satisfaction level of the users of ICS; and iv. select some models of ICS that will be recommended for further experimentation. Local partner NGOs of VERC and Practical Action were selected for this study. Data collection was done by interview, informal discussion and observation using structured questionnaire and checklist. A team consists of three researchers conducted the survey in July-August 2006. Study found that, basically the sampled households used two types of ICSs. These were fixed and portable ICS. About 56% of the households used fixed typed ICS, majority of which were without grate. Fifty-four percent of the users were completely satisfied with ICS. There are some limitations of using ICSs mentioned by the respondents. However, majority of the users mentioned some advantages of ICS that include creating less smoke in the kitchen, less time to cook, saving energy (fuel), etc. Fifty-six percent of the households used traditional cook stoves in addition to ICSs. A number of reasons behind using traditional cook stoves they mentioned which include feeling comfortable, fuel easily available, cheaper to use, meeting seasonal demands etc. However, majority of them said that they were habituated and felt comfortable in using traditional cook stove in addition to ICS. Study shows that 24% of the households faced problems related to fuels such as: cost of firewood, availability, smoke especially in the rainy season etc. However, all of the households were agreed to use ICS continuously. Among them seventy-three percent were agreed to pay for new ICS. Most of them opined to pay within the range of Tk. 50-100 for new ICS. It is quite clear from this study that any fixed type of ICS would not be suitable for all areas and households. Selection of appropriate and popular ICS depends largely on availability of fuels, energy savings, and reduction in smoke emission. However, an effective laboratory test of selected ICS models is needed to find out the appropriate one that may be replicated countrywide after successful pilot intervention.

## INTRODUCTION

It is fact that Bangladesh has only 9-14% of land under forest cover (Glow 2002). A scientific approbation that having 25% of total land under forest cover is must in order to sustain ecological balance. More than 80% of country population live in rural areas in Bangladesh. Most of them use fuel wood, straw, twigs, leaves, rice husks, jute stick and other agricultural residues as fuels for cooking purpose. The annual consumption of these fuels is about 39 million tons and it is about 83% of the total consumption in the country. It should be noted that only 4% of the population is covered through the natural gas supply networks in Bangladesh. Even most of the semi-urban and urban population use traditional fuels for cooking purpose. The use of traditional fuels is also being increased with rapid population growth. As a result, deforestation and consequently a change in the ecosystem are happening that in turn leading to soil erosion and climate change. Therefore, wise use of traditional fuel is necessary to protect vegetation. Improved cook stove, instead of traditional biomass cook stove can ensure efficiency in use of traditional fuels<sup>1</sup> (World energy council 2005). Moreover, improved stove reduces smoke emission and health hazards especially to the cook<sup>2</sup>. Improved stove saves 50-70% fuels compared to traditional ones. In the case of chimney stove, flue gases are also taken out of the kitchen so that the kitchen becomes more comfortable for the cook. Other benefits of improved stove are: save cooking time, less smoke, less blackening of the utensils, saving of fuels, portable stove can be shifted easily during rainy season, etc. Institute of Fuel Research and Development (IFRD) in Bangladesh developed a number of models of improved stove. Besides, some of the NGOs in Bangladesh are actively involved in dissemination of ICS technology among the community members especially in the rural areas. A variety of improved cook stoves have been designed and developed which include fixed and portable type, metal and clay, single and multiple pot, with chimney and without chimney, with grate and without grate, etc. More than 100 NGOs are being working locally with different models of ICS. Most of them are on pilot basis. Appropriate model to replicate countrywide is yet to know. This study attempted to know which types of ICS people accepted more. Based on their preferences, further experimentation will be carried out to determine the best one that should be replicated countrywide.

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<sup>1</sup> The traditional stove commonly used in Bangladesh is a mud-built cylinder with three raised points on which cooking utensils rests. One of the three spaces in between these raised points is used as fuel feed and the other two for flue-gas exits. These stoves may be built under ground or over ground. These stoves cause unnecessary heat loss due to some reasons which include i, the stoves are too deep and because of large distance between the pot and the fuel bed, heat transfer to the cooking pot is very low, resulting into low efficiency, and ii. because of the large size of the flue gas exits between the cooking pot and the stove, much of the flue-gas get out of the stove without coming into contact with the cooking pot thus lowering conventional heat transfer.

<sup>2</sup> Apart from low efficiency of traditional stove, it emits smoke, which affect the health of the users especially cooks and make the kitchen dirty. Because of incomplete combustion of biomass fuel in traditional cook stoves, appreciable quantities of irritants, toxins and carcinogens, are released in the kitchen environment and these pose a major threat to the respiratory system of the users. In general, the combustion products of wood are carbon dioxide, water vapour and carbon monoxide, particulate and polycyclic organic matters. The last three known are to be pollutants hazardous to human health.

## **Objectives**

- To know what fuels are being used in improved cook stove for cooking purpose;
- To know what types of ICS are being used and preferred;
- To know the satisfaction level of the users of ICS; and
- To select some models of ICS that will be recommended for further experimentation.

## **METHODOLOGY**

Some NGOs along with Bangladesh Council of Scientific Research (BCSIR), are working with improved cook stove program in Bangladesh. Among them (NGOs), Village Education Resource Centre (VERC) and Practical Action (PA) are playing a vital role in dissemination of Improve Cook Stove (ICS) technology. At present more than 100 national and local NGOs are implementing ICS program at the grassroots level under the supervision of VERC and PA. Activities of these NGOs at the root level include raising awareness level of the community members on ICS, providing community people with training on how to construct ICS, developing local entrepreneurship, providing necessary logistics to construct ICS, monitoring, and evaluation. Six partner local NGOs of which two of VERC, and four of PA were included purposely for the study. Experience on ICS program of both PA and VERC was also included in the study.

Two partner NGOs of VERC named Unnayan Dhara at Jhinaidah, and WDP at Gaibandha and of PA: Dhara, Swapna, SEED, and UDP at Jessore, Bogra, Rangpur, and Dinajpur respectively were included. Data were collected using structured questionnaire from forty-one households. Besides, informal discussion and observation were also made for data collection. Households were selected purposely based on their experiences and availability of existence. Married women involved directly in cooking in the households were selected as respondents. It should be noted that in principle we were committed to seeking consent of the respondents before conducting interview. Based on their willingness to provide information, we conducted interview. A team consists of three researchers conducted the survey in July-August 2006.

## **FINDINGS**

Average family size was 4.5 (Min 3, Max 6) in 68% of the households. About one-third households had more than six family members. Members above sixty years were found in a few (20%) of the households. Female members (mostly wives of household heads) involved in cooking spent 2.5 hours on average (Min 1.5, Max 3.5) a day for cooking. Involvement of daughter and grandmother in cooking was found in some of the households. Fifty-four percent of the households were used to cook twice (Morning- Afternoon/Evening) a day. About one-third (32%) of the households cooked thrice (Morning-Afternoon-Evening) a day and most of them purchased fuel for cooking.

Basically two types of ICSs were used by the households included for the study. These are fixed and portable based ICS. About 56% of the households used fixed typed ICS majority, of which were without grate. Placement of the ICS was either in a corner inside the room, or in a covered-shed sharing a wall with the room in most (78%) of the households. Act of cooking done by only one person at a time in the household was existed in seventy-one percent of the

households. About 56% of the households used ICS for six months only. A very few (12%) of the households were using ICS for more than one year.

**Satisfaction level of the users with improve cook stove (ICS)**

Fifty-four percent of the users were completely satisfied with ICS and they did not face any difficulty in using ICS. A partial satisfaction among the remaining (46%) of the households was found in the study. They faced a little bit difficulty in using ICS. Difficulties include lack of opportunity to spend time to do other familial works during cooking especially with portable ICS with grate, all kinds of biomass fuel cannot be used in ICS, and sometimes fuel not easily available. According to Joseph (1981), many times, the improved cook stove designs are found to be incompatible with traditional ways of cooking. For example, any change required in the posture of the cook while cooking may not be accepted. Grate in ICS is placed at the middle stage. Fuel mainly firewood is kept on the grate while about 50% of the firewood remains outside the stove. After a few minute cooking/burning, outside portion of firewood is displaced and fall-down in absence of the cook. So, a continuous attention of the cook to firewood during cooking must be maintained. In addition, this type of ICS may not be suitable for fluffy fuels, such as leaves, agri-residues, etc. (Quadir 1995). The improved cook stoves may allow use of only certain sizes and types of fuel wood, thus further constraining the choice of fuels (George 1990). However, majority of the users mentioned some advantages of ICS that include creating less smoke in the kitchen, needs less time to cook, saving energy (fuel), and portable ICS can be shifted anywhere when required. Some other advantages (food more tasty, no or minimum black spot in the cooking pot especially at the lower portion) were also reported.

**Use of other stove besides improve cook stove (ICS): Types and reasons**

Fifty-six percent of the households used another cook stoves in addition to improve cook stoves (Table 1). Most of them (87%) used traditional clay fixed cook stove. A number of reasons behind using traditional cook stoves they mentioned which include feeling comfortable, fuel easily available, cheaper to use, meeting seasonal demands e.g. boiling rice in large pot, etc. However, majority of them said that they were habituated and felt comfortable in using traditional cook stove in addition to ICS. Any of the new things though introduced with a view to maximizing wealth and minimizing bad impact on total system takes time to be accepted and established. Members of the households are normally habituated to continue to use the things they got traditionally and hereditarily. Improve cook stove has some limitations. It does not permit all types of pot to be used for cooking purpose (Quadir 1995). Besides, the person(s) involved directly in cooking does not have opportunity of sparing time to other familial works.

**Table 1. Use of other stove in addition to ICS**

Use of other stove?	Study household	Types of other stoves used		Reasons for using	
		Clay fixed stove	Others	Comfortable, habituated	Others
Yes	56	87	13	78	22
No	44	-	-	-	-
n	41	-	-	-	-

**Use of fuel: Types, methods of obtaining, and cost**

Most of the households used wood, logs, dry leaves, hay, straw, jute stick, and bamboo as fuels. Some of the households were habituated in using cow dung as fuel. Rice husk, charcoal, twigs were also used in some of the households in improved cook stove. Majority of the households (63%) collected fuels free of cost. Some of them used fuels through both

purchasing and gathering. A few of the households purchased fuels on regular basis for cooking. In the study it was found that rate of involvement of the female members in the household in obtaining fuels was higher. Wife in the household was responsible to collect fuels free of cost in most of the cases. Husband in the family was involved in purchasing fuels in some cases. However, either wife or daughter used to gather fuels for cooking in most of the households. In gathering fuels concerned family members spent time more than 6 hours on average a week. Those of the households used to purchase fuels, most of them had monthly expenditure of Tk. 300 on average (Min Tk. 200, Max Tk. 400) for fuel.

### Use of fuel: Problems and preferences

Study shows that twenty-four percent of the households faced problems related to fuels. The problems included expensive in case of purchasing firewood, not easily available for gathering free of cost, produces lot of smoke in case of watery fuel wood especially in the rainy season. Of course, majority of the households who did not face any problem related to fuels mentioned some reasons behind using the fuels. These were affordable price, availability of the fuels including free of cost, and habituated. A wide variety of fuels which are available especially in rural Bangladesh can easily be used in improve cook stove. Most of the households preferred firewood, dry leaves, twigs, hay, straw, and rice husks as fuels. Some of the households preferred cow-dung as fuel.

### Preferences to different types of improve cook stove

The households included for the study practiced different types of ICS. Most of them (66%) preferred fixed improved cook stove (Table 2). There are mainly two types in fixed pattern, fixed cook stove with grate and without grate. Majority (74%) of the respondents preferred fixed ICS without grate, as they felt comfortable to use it.

**Table 2. ICS: Sustainability**

Agree to continue to use?	Study household	Agreed to pay for new ICS	Study Household	Intended amount to pay	Study household
		Yes		73	
				50-100	73
<b>Yes</b>	<b>100</b>	No	27	-	-
No	-	-	-	-	-
n	41	-	41	-	30

### Sustainability

Respondents were asked if they are agreed to continue using ICS. All of the households were agreed to use ICS continuously. Among them seventy-three percent were agreed to pay for new ICS (Table 3). Most of them opined to pay within the range of Tk. 50-100 for new ICS. Based on these imperative responses it seemed optimistic towards expansion and successful implementation of ICS project and thus it will address sustainability of ICS.

**Table 3. Preferences to ICS**

Types of ICS	Study household	Fixed status	Study household
Fixed ICS	66	Without grate	74
		With grate	26
Portable ICS	34	-	-
n	41	-	27

### **Popular Improved Cook Stove (PICS) at different areas**

Community people at different areas used different types of ICS. Study showed that popular ICS model at different areas was different in most of the cases (Table 4). There was no any fixed popular ICS model for all the areas. Grate-less portable single stove in Jessore, grate-less fixed double stove with chimney in Jhinaidah, portable single stove with filter plate in Bogra and Dinajpur, and fixed single stove with filter plate in Gaibandah and Rangpur were popular. In most of the areas, grate-less single stove was popular due to having advantage of using different types of fuel (such as wood, agricultural residues, and dung) and majority of the improved cook stove users were fuel gatherers of these types of fuel. Double stove with chimney was popular as it reduces smoke emission especially in the kitchen. Portable cook stove was preferred during rainy season. Besides cooking with filter based fixed single stove through especially fuel wood, other familial works can also be done.

Different types of improved cook stove found in the study were as follows:

- A) Fixed:
  - i. Single stove with filter plate
  - ii. Single stove without filter plate
  - iii. Double stove with chimney
  - iv. Double stove without chimney
  
- B) Portable:
  - i. Single stove with filter plate
  - ii. Single stove without filter plate
  - iv. Double stove without chimney

### **Recommended ICS options for future experiment**

Based on study findings it is clear that different types of ICS were existed at different areas in Bangladesh. No any one type was fixed, best, and popular for all the areas. Which one appropriate and popular was determined by and depended largely on availability of fuels, energy savings, and reduction in smoke emission, though there was no laboratory test to measure energy efficiency and kitchen air pollution. Most of the users opined based on their observations. However, to conclude which one is appropriate in terms of energy saving, and air pollution control especially kitchen air pollution needs an effective laboratory test of following ICS models:

- Model – 1: Single pot-cook stove
- Model – 2: Single pot-cook stove with grate
- Model – 3: Double pots-cook stove
- Model – 4: Double pots-cook stove with chimney
- Total: Four cook stoves in number



**Table 4. Popular Improved Cook Stove (PICS) at different areas under different NGOs**

Area	Organization	PICS	Cost	Address energy savings	Address IAP	Effective Fuel	Remarks/ Reasons of being popular
Jessore	Practical Action (PA): Dhara	Grate-less portable single stove	Tk. 20	Yes	No	Fuel wood	- Different types of fuel like leaves, agri-residues, twigs, cow dung, wood etc can be used in ICS. Majority of the improved cook stove users were gatherers of these types of fuels.
Jhenaidah	VERC: UD	Grate-less fixed double stove with chimney	Tk. 50	Yes	Yes	Fuel wood	- Reduction in smoke emission - No smoke emission into the indoor environment as it goes outdoor through chimney - Less time to cook - Different types of fuel based on users' abilities can be used
Bogra	PA: SWAPNA	Portable single stove with filter plate	Tk. 70	Yes	No	Fuel wood	- Availability of fuel wood - Can be shifted during rainy season (This is where especially low land area and is waterlogged with somewhat raining)
Gaibandha	VERC: WDP	Fixed single stove with filter plate	Tk. 70	Yes	No	Fuel wood	- Different types of fuel like leaves, agri-residues, twigs, cow dung, wood etc can be used and majority of the improved cook stove users were fuel gatherers - Other familial works can be done during cooking
Rangpur	PA: SEED	Fixed single stove with filter plate	Tk. 60	Yes	No	Fuel wood	- Availability of fuel wood - Other familial works can be done during cooking with using fuel wood
Dinajpur	PA: UDP	Portable single stove with filter plate	Tk. 60	Yes	No	Fuel wood	- Community prefer portable stove as most of the households have no extra land to spare for cooking purpose - Stove can be shifted during rainy season

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**A supplementation**  
**Assessment of Improved cook stove: Qualitative analysis in brief**

**Target group:** Households started once to use ICS but did not continue

**Objective:** To know the reasons for not continuing the use of ICS

**Data collection**

Data were collected through focus group discussion and case study from the households who started to use ICS but did not continue. A total of 10 case studies, and 9 focus group discussions with the households that did not continue to use ICS were conducted in December 2006-January 2007. Study area included Manikgong, Kishoregong, Chittagong Urban, Jhinaidah, and Bogra. These areas were selected based on availability of the ICS-program.

**FINDINGS**

Qualitative study identified several issues as reasons for not continuing the use of ICS. They also mentioned some features of ICS and suggested few points to improve the condition and use of ICS. Those are described in following section.

**Location of ICS**

In some cases ICS was set up at open place and it was damaged and cracked by raining, soil was not available to reconstruct ICS. Some of the respondents said that grate of ICS was stolen and they felt uninteresting to purchase again the grate. One of the users claimed that a leg of her child was burnt due to entering the leg into the route of airing in the ICS. The woman closed the route and used the ICS as traditional stove. In some cases, ICS was abolished because of building new house in the place where ICS was constructed. Continuation of use of improved stove was not possible as there was no kitchen in the house due to land shortage in some cases.

**Technological**

Users claimed that ICS produced more smoke during cooking and they were in trouble. In some cases users claimed that the temperature/heat in the stove during cooking was low and required more time to cook. This is because the design of ICS allowed passing out some heat and fire through the large diameter based channel, which caused heat deficiency. It was not possible to shift fixed ICS from open place especially during rainy season and from closed/dark environment to open place during winter season.

Some of the users said that ICS needed extra care to keep it suitable for cooking as it used to become cracked frequently due to heat and getting wet. In some cases, users mentioned that it was not possible to cook for large number of family members at a time using ICS. Because the design did not allow to use large pot for cooking.

It was also needed to remove ashes frequently during cooking for which some of the users felt boring and stopped using ICS. They thought that rate of smoke-emission was higher in grate based ICS as complete fuel wood combustion was not maintained in some cases. Some household members said that the depth of grate placement was undersized, so that ashes became deposited almost immediately after started cooking and caused insufficient combustion and required more time to cook.

In some individual cases users believed that fire was confined to inside the stove due to its design especially low prongs on which cooking pot was set up and produced more smoke during cooking. Therefore, they converted it into traditional stove.

### **Fuel options**

In one place, some of the users mentioned that they were not able to purchase fuel wood on regular basis for ICS. However, they had opportunity to get agricultural residues, leaves, and branches free of cost for cooking. Since these agricultural residues were not suitable for ICS led them refrained from using ICS.

### **Raw materials and time constraint**

Lack of soil and other components like brush, technology led the users reluctant to reconstruct the damaged ICS for the first time in most of the cases. Users also claimed that more time was needed to construct ICS. Users in some cases stopped using improved stove because of damaging and they had no time and opportunity of getting soil to reconstruct. They needed more time to manage particular type of fuel for improved stove (as the improved stoves allow use of only certain sizes of fuel wood pieces) that was thorny-problem they felt.

### **Quality/taste of cooked food**

Some of the users claimed that there was no taste of rice, vegetables, and other foods that were cooked using improved stove.

### **Culture**

Some other users felt uncomfortable to use improved stove, as they were not habituated.

### **Maintenance**

In some cases user did not pay proper attention to maintenance of ICS when needed. Monitoring and follow up on regular basis by the service provider was not maintained properly.

### **Improved stove used by the users and duration of usage**

Users used different types of improved stove. Some of the users used portable single pot with grate, some used portable stove without grate, and some used fixed single pot with and without grate. Fixed double pots with chimney were used in some cases. Pattern of improved stove was different at different places that was depended largely upon the NGOs who introduced improved stoves among the villagers. About 50% of the users used improved stoves for 6-12 months and 40% of the users used for not more than 6 months. A very few used ICS up to 18 months. Some users stopped using after one month even some stopped one week after starting.

### **Economic status of the users**

Almost half of the users had surplus economic position while they maintained their expenses with their existing earnings and income of them was higher than their expenses. About 30% of the users faced deficit economic status.

## **Comments on some features of any kind of cook stoves**

Factors affecting use of cook stoves as mentioned by most of the users were:

- fuel cost,
- provision of using more types of fuel,
- time of cooking,
- having a sit by the stove while cooking,
- number of cooking chambers,
- smoke in the house/kitchen,
- taste of food,
- portability of stove, and
- less coughing and feeling better.

The feature 'number of cooking chambers' was not important to some of users. Features 'smoke in the house', 'portability of stove', and 'less coughing and feeling better' were ranked highest (grade1).

## **Suggestions from the users who stopped using ICS**

With a view to increasing the use and demand of ICS, following suggestions were made by the users who did not continue to use ICS due to facing some unfavorable conditions:

- i. Design of improved stove should be at a level that will ensure minimum smoke emission during cooking and minimum rate of incidence of cracking and damaging
- ii. ICS should be designed with having provision of using all types of agri-residues, leaves, and branches including fuel wood
- iii. Depth inside the stove should be enlarged, so that the removing of ash and/or charcoal from inside the stove would not require frequently.
- iv. Grate in the stove should be well designed with the intention that ashes will not be piled up rapidly
- v. Many poor people in the villages are not even capable for paying of minor maintenances cost, such as replacement of grate, chimney, etc. So there should be a provision of subsidy especially for the poorest so that they will continue in using the improved stove.
- vi. Existing improved stove system does not permit the use of all pot sizes/ or shapes (small-large). Technology with a provision of using different pot sizes especially small large if ensured, it may lead to increase the demand of improved stove.
- vii. Awareness related to particularly maintenance of improved stove among users should be developed
- viii. Effective monitoring on regular basis by the organizations instigated improved stove may ensure the sustainable continuation of using improved stove.