Technology in Context for Rural Bangladesh: The Options from an Improved Cooking Stove for Women

W.K. Biswas*, D. Bryce** and P. Bryce***
*Institute for Sustainable Futures, University of Technology, Sydney
**Appropriate Technology for Community and Environment, University of Technology, Sydney
***Faculty of Engineering, University of Technology, Sydney
Australia
Email: wahidul.biswas@uts.edu.au

Abstract

In a field study of a cluster of Bangladeshi villages, in which the application of renewable energy technologies was tested for contextual relevance, cooking was found to be the only activity where the transfer of a time-saving and drudgery-free technology offered practicable opportunities for major lifestyle improvements. Improved cooking stoves (ICS) was the most appropriate technology compared to other alternative technologies such as biogas, solar heaters, and briquetting in the socio-economic and climatic context of Bangladesh.
This paper discusses a contextual mechanism through which ICS can provide time for rural Bangladeshi women from landless and marginal farmers' (LMFs) households. This time could be spent on income generation activities, an option enjoying considerable currency within women's responses during the study, without affecting their time allocated for other daily activities including resting hours. A study of women's daily activities implied that the replacement of an existing cooking stove by an ICS would release a time slot of 1.5 hours a day, most suitably between 6:30 and 8:00pm. In this scenario, sunshine-dependent activities, such as clothes drying, paddy and fuel processing remain as daylight activities. Some evening activities would likely be rearranged to earlier periods, using the time flexibility provided through ICS.
A mechanism is discussed that combines women's expressed preference for generating income, the skills available and the financial requirements of a technology transfer for domestic cooking and lighting. The women from LMFs' households have been found to be skilled in sewing clothes and mat, pup rice making, and paddy par boiling. These women may use the saved time, and electricity from a rural cooperative, to generate income at night. We find this mechanism can be viable, where the income surplus is able to pay the electricity bill and repay the loan taken for ICS.

1 INTRODUCTION

Women in Bangladesh, particularly in the rural areas, are a disadvantaged class with low social status. Although poverty in the LMF group is prevalent amongst men as well as women, far more women suffer from poverty due to this gender status. Social customs and religious beliefs play a dominant role is shaping society's attitude towards women. They generally lack access to productive resources, remunerative employment and education opportunities. The Rural Industries Study Project (RISP) found that women were participating in different kinds of economic activities as unpaid family workers, but seldom were they regarded as owners of the enterprises, nor did they receive a share of the income (Khanam, 1993). They were not explicitly involved in family financial decision making, nor regarded as earning members as their economic activities were not earning cash. They participate in almost all processes of crop production, but social custom discouraged travel to markets for selling their products or purchasing raw materials. While providing their labor, the resulting cash is handled by others and used through decisions by others. They are economically dependent on men even for the basic necessities of life such as food, shelter, clothing and medicines (Siddique, 1996).

The domestic financial situation in LMF households often leads to some loosing of cultural/ religious norms that constrict women's movement (White, 1992). Children and women from the poorer families can be hired out, although their ability to attract adequate wages is weak in comparison to men. However, a mechanism for women's self-reliance through direct cash generation, within social custom boundaries, may be possible.

To increase their disposable income, poverty-affected rural women need sufficient financial credit facilities along with training for production of various farm and non-farm products. Institutional support is also needed for marketing their product.

There are institutions like Bangladesh Rural Development Board (BRDB), Grameen Bank, BRAC, and Swanirvar carrying out women development program in Bangladesh. As well, USAID had funded the Women Entrepreneurship Development Program (WEDP), implemented by the Bangladesh Small and Cottage Industries Corporation (BSCIC) (Khanam, 1993).

As a prerequisite to sustainable help in rural situations, women also need disposable time. One of the major constraints to enterprise development by rural women has been found to be the burden of household work (Khanam, 1993).

The situation suggests the use of technologies that rural woman uses technologies to reduce the time-burden (and drudgery) of rural household work. The other constraints are illiteracy, lack of technical skill, social and cultural inhibitions and inadequate and ineffective training facilities.

The aim of this paper is to partly empower rural women from Landless and Marginal Farmer (LMFs) households through appropriate energy technologies. It also discusses how a woman may be able to own, in her own right, a drudgery-free energy technology. The paper is divided into two parts. First, it assesses the time saving opportunities from the use of technology for their existing activities. Secondly, it discusses the financial and management issues involved in income generation activity from existing skills, given that women in the study area take up their proclaimed preference for employing that time saving for cash generation. Firstly, we summarise the context of this study:

2 THE RESEARCH

Our research has been carried out in Hiran and Polsair villages under Kotalipara thana of the Gopalganj district. These villages represent aforementioned characteristics of the villages in this district. In Hiron, about 90% of the population are Muslim and 100% of the population in Polsair are Hindu. The selection of the villages from two religious groups helps to assess the impact of cultural differences in technology diffusion and income generation. Women from 20% of the total LMF households in Hiran (i.e., 44 sampled households) and Polsair (i.e., 19 sampled households) villages were randomly sampled for interviewing.

2.1 Women's Workload

Women from landless and marginal farmer households (LMFs) were of particular interest. Their daily 'diary', their skills and their income generating activities were recorded. This section of the questionnaire aimed to assess the full extent of women's responsibilities and preferences. The following main activities comprise several sub-activities.

- Cooking activity includes all ranges of activities from withdrawing ash from the stove till cooking is finished. Fetching water for cooking, chopping are included in this activity;
- Cleaning activities includes reinforcing houses and plat forms, washing clothes, cleaning floors etc..;
- Responsibilities on family members include feeding kids and family members, folding band preparing bed for them,
- Agricultural activities include raising and feeding poultry and livestock, gardening
- Fuel processing activities include fuel drying, chopping, gathering etc..
- Personal activities like eating, bathing
- Resting and social obligations

Accordingly, the following criteria were considered
- The energy technology may reduce drudgery and save time.
- The time being saved due to use of these technologies may be used for income generating activities.
- The income generation activities should not affect commitments to households activities performed by her.
- The rural women involved should not experience increased work load.
- The income would be able to pay for the initial investment along with their wages

2.2 Scope of Income Generation Activities

The average workload for these activities would help find opportunities to reduce their time through the use of time saving and drudgery free technologies. The women can reschedule their workloads by themselves if they are interested in carrying out income generation activities during these time slots . Rural women have also been asked about the most troublesome activities carried out by them in order to facilitate the choice of technologies.

Their indirect (gardening, raising livestock) and direct (physical labour) incomes were recorded. Their interest to perform their skills to generate income were also known and so the resources (capital, training) required to utilize their skills were recorded.

3 SURVEY RESULTS

3.1 Work load Pattern

Cooking and responsibility for family members occupies a major portion of their daily load curve (i.e., 51 to 54%). Agricultural activities are performed more by Hindu women than Muslim women. Hindu women spend more time in gardening than Muslim women. The resting and personal activities in both of these villages vary from 15% to 22%. Muslim women are found to spend longer time in religious activities than Hindu women.

Our survey found that cooking occupies most of the time in the morning and late afternoon. Most of the Muslim LMF women are found to start cooking earlier than Hindu LMF women as Muslim women need to say their first prayer before the sunrise. In both religious groups, most of the women finish their cooking for the last meal before sunset (i.e, before 6 o'clock). Most of the LMF women in both villages (i.e., 60 – 70%) finish their daily activities by 9 o'clock in the evening. Rural women contribute significantly less time in income generation activities (direct and indirect) than household activities. Excluding sleeping, they spend on average 18 hours a day including two and a half hours of rest or free time which is quite reasonable. The activities such as cleaning utensils and washing clothes take place in early and late morning to allow sufficient time to dry them under the sun. They prefer to do gardening in the late afternoon after finishing the most essential household tasks.

Housewives spend more time looking after children than other activities under the heading of family responsibilities. By culture, rural women are responsible to serve food to all family members. If children are small, mother spends a significant amount of time for holding, bathing, feeding children. Accordingly, the prospect of time–saving technologies for regular tasks in some families may not lead to income generating activities, given the expanding needs of children.

3.2 'Drudgery' Activities of Rural LMF Women

The nature of the job and the technologies used to perform these jobs have been investigated to find ways to alleviate their drudgeries. Thirty two percent of the households in Polsair village saw rice husking as the most troublesome activity. The respondents suffer from carrying straw from the field (21%), cooking (16%), fetching water (5%), par boiling (5%), respectively. The rest (21%) of housewives declined to offer specific activities as particularly burdensome. Polsair village also ranked paddy husking as the most burdensome activity. Cooking has been found to be the third most tiresome activity performed by the rural women in Hiran village. Unlike Polair village, carrying straws is not a tiresome activity in Hiran village; because Muslim women are seldom encouraged otherwise to go to the field. Although cooking activity has not been found to be the most troublesome activity by the majority of rural women, there is an opportunity to save time in this activity. Moreover, it is a seasonal activity. The housewives struggle a lot for gathering fuel. What they carry in 1 day, they use then for 3 to 5 days. Even mother in laws often assist housewives in carrying straw from the field on alternate days. The women from this group can hardly afford labor to get straw fuel back from their small piece of land or shared land. Their husbands cannot be engaged to do this task as they had to live from hand to mouth and husband performs the cash transactions.

3.3 Drudgery Free and Time Saving Potential of Cooking Activity

Cooking has been found to be an activity where technology substitution is possible. The technology substitution could have been considered in the case of rice husking since the conventional human muscle operated equipment have been found to be time and effort intensive. Our estimate from the field survey shows that they husk on average 15 kg paddy in 8 hours a day, while the machine takes 3 minutes to husk the same amount of paddy. Rural women are found not husking all paddy at a time (i.e. 20 to 40 kg on average per time) in order to avoid storage problem and possible insects' attack. However, the replacement of dheki by a rice husking machine has two constraints:

- The process is confined to household scale for practical reasons.. Landless and marginal farmers obtain paddy instead of cash when they work as farm labor. If they get cash instead of paddy, they would buy less rice than they would have obtained for processing the paddy. So they get all paddy processed at home.
- An engine operated rice mill technology is far beyond their affordability. The cost is about the double of their annual income.

Cleaning activities cannot be shifted in the later hours as this requires sun drying. Also, time saving would not be significant as all clusters have small pond or a canal and tube wells close to their houses.

Cooking has therefore been found to be the activity where intervention of improved technology can take place to save time and drudgery. The cost of cooking technology is much less than the cost of rice husking machine or water pump. The time saved in cooking due to use of improved stove in the preceding hour can be replaced by responsibilities for family members ie, time for feeding family members would be earlier. This allows some free time in later hours where income generating activities can be done.

Housewives were specifically asked about the problems in cooking. Thirty two percent of the respondents in Polsair village reacted that they suffer from headache, radiation from fire and their headache starts when they are exposed to fire. Women in the village are found mostly to use straw (locally known as nara) and dung cakes. The disadvantage of these fuels is that it kept the cook always busy as fire climbs up quickly because of the nature of stove. Also, a large quantity of these fuels are required to meet the same energy demand because of lightness and low calorific value of the fuels. Consequently, the woman has been found to insert these fuels continuously into the fireplace of the stove until cooking is over. Therefore, the cook cannot concentrate on other activities: looking after kids, preparation or chopping of other items of meal during cooking. Even housewives sometimes cook holding their kids; thus kids are exposed to smoke.

Muslim households, the man usually gathers fuel even taking some time from the income generation activities. If husband is tied up with daily wage work, they even send their school going sons and daughters for gathering fuel. A man sacrifices his 6 days work to gather fuel. The opportunity cost of six days is Tk. 180 since they earn Tk. 30 per day from weeding activities during this period. Old women also sometimes suffer from such drudgeries as young housewives are usually overburdened with family activities. The use of improved cook stove may be able to overcome these problems.

3.4 Women's Interest in Income Generation Activities

The woman's view regarding joining the business or enterprise has been recorded. About 60% of the respondents have interest to generate income in Hiran village while 32% did not answer the question. Only 8% said directly '*no'* as they may not be able to attend their kids properly. Those women interested in income generation activity were then asked if there would be any social barriers to perform these activities. The responses are as follows:

- 42% of the interested women group placed food and income above any sort of social obligations. Some of their statements are like that the society would not feed on them if they do not work. One respondent's husband stated that extra income by her wife to his family is like saving life or *faraj*[1].
- 8% would seek their husband's approval before starting the job.
- 19% expressed their interest to work within cluster, avoiding hawker type jobs, and to deal with women customers only.

[1] Faraj is an Arabic word which means an essential task to be performed under Islamic religion. According to Islamic law, saving life is *faraj*.

- 2% stated that it would be difficult to work with children, although they told their mother in laws that can look after their children.

The rest did not express any thing on barriers to income activities.

In the case of Polsair village, most of the respondents (70%) are interested to be involved in income generation activities while 10% showed no interest and the rest did not answer to this query. Like Hiran village, the interested respondents' have also been asked about any barrier to their being involved in the income generation activity. Types of responses to this question are given below:

- 23% of them said that they would like to work within a cluster but they would give more priority to their household works
- Another 23% responded they can do anything for food. They can even handle human excreta if they are involved in a biogas project.
- 8% of them have some hesitation to handle human excreta, otherwise they have no problem.
  8% told arranging time for income generation activity is not a problem.
- 38% simply said that it would not be a problem being involved in the business.

It appears that the large portion of LMF women in these villages are interested to work for generating extra income for food and other basic needs. In Hiran village, working within the village would be preferable. In the case of Polsair village, competition between of household tasks and those of income generation would not be preferred. Local job creation needs to be looked at on the basis of women's existing skills and the introduction of some time saving cooking technologies needs to be considered so that productive households activities are not disturbed.

3.5 Local People's Perceptions on LMF Women Involvement in Work

The perceptions of wealthier households' heads (usually the man) have been recorded, regarding LMF women's involvement in the income generating activities. In the case of Hiran village, about 34% of the households are against women's involvement in income generation activitiy while only 16% supported. Those who had supported suggested that women can work but under purdah. The rest did not make any comment on it. Their maximum limit of movement would be the nearby clusters of her house. Some suggested that woman to women business transactions would be better. In Polsair village, about half of the heads of the families from the wealthier households support women's involvement in income generating activities while 32% opposed directly. Some heads' perception is that women's responsibility is to cook only.

However, some people can be found from the wealthier households supporting women's participation in income generating activities. Nevertheless, income generation activities for the women needs to be designed in a way the whole rural society is satisfied.

3.6 Income Generating Activities Performed by the Rural Women

Most of the LMF women are found to be already involved in income generation activities. It is now essential to know what skills do they have to generate income. Other than household activities, women had also been asked about their income generation activities. This included both of their direct and indirect income generation activities. The information regarding their unused skills and resources required to utilize these skills have also been gathered.

The women from Hindu village (Polsair) have more direct income (i.e. 26%) than that of LMF women (7%) in Hiran village. The direct income generating activities performed by these women are weeding, sewing clothes, making irrigation channel etc.. Land processing activities account for about 71% of the LMF women involved in direct income in Polsair village, while 100% of the LMF women in Muslim village have been found to have sewing as direct income. Women from Hindu village have been found weeding land and lining irrigation channel in the paddy field which is quite culturally unlikely for the women from Muslim households. A Hindu housewife of an ill husband was found to work in the field while a Muslim widow works for rich man's household activities in the village. On average about 50% to 60% of the Hindu women carry out land processing works

during Magh to Baisak (i.e. from mid January to April) for 6 hours a day basis. They receive Tk. 25 a day, while a man receives Tk. 30 a day.

Although the wage is relatively high (Tk. 7 to 10 per hour) for sewing a blanket in local context, 5 to 6 times higher wages can be obtained in cities. On average, they can sew 10 blankets a month and earns Tk. 200 a month.

Indirect income consists of activities like raising livestock, house-side vegetable gardening, and assisting their husband processing agricultural land. The majority of LMF women in both villages fall in the category of women with indirect income and possessing skills for other jobs. Most of the women of this category (i.e, 60%) in the Muslim village raise poultry while only a few (25%) are involved in the Hindu village. Gardening and poultry accounted for 50% and 26% of in the indirect income generation activities in Hindu village. Gardening activities usually take place during Agrahion to Magh (mid- November to mid- January). The income from poultry ranges from tk. 300 to tk. 2400 per year. Their gardens usually supplement half yearly vegetable need. Quite a significant portion (i.e. 27%) of women in the Muslim village generate no income and appear to possess not potentially negotiable skills.

3.7 Unused Skills Among LMF Women

Although, almost all Hindu LMF women are involved in some sort of direct and indirect income generation activities, most of them are found to have unused skills. These unused skills are paddy processing, raising livestock and operating sewing m/c for making blankets, embroidery and lady's garments. Sewing accounts for about 25% of the unused skills of these women and they can operate sewing machine. About 50% of the LMF women in the Muslim village have unused skills. Sewing has been found as an unused skill less in Muslim village (i.e, 12%) than in the Hindu village. This is because Muslim LMF women find sewing harmonic with their culture and don't keep such a skill unused even they don't have sewing machine. Moreover, they have cultural constraint to carry out all steps paddy processing (ranging from paddy parboiling to selling to the market) work. Since Hindu women does not have cultural barrier to carry out field oriented works and processing activities which generates quick cash, they are found more interested to join this work.

4 TOOL FOR EMPOWERING LMF WOMEN THROUGH IMPROVED COOKING TECHNOLOGY (FIELD OBSERVATION BASED APPROACH)

The empowering tool is termed as field observation based approach or bottom up approach as the following theory has been developed on the basis of LMF women's needs, work load pattern and skills. A model for time reallocation is as follows:

Step 1

The reduced cooking time due to use of improved cooking technology (ICT) is expressed as,

Time required for cooking using existing cook stove x percentage of time saved due to use of ICT

Time saved due to use of ICT is expressed as,

Time required for cooking using existing cook stove – Time required for cooking using ICT

Step 2

The existing cook stove keeps women always busy in controlling the fire. In the case of the ICT, food preparation (i.e, chopping, fetching water) can take place along with the cooking, as the stove offers controlled combustion. Therefore, the extra time spent on food preparation can be avoided.

Time for food preparation for cooking due to use of ICT (in hours) is expressed as,

i) if Time saved in cooking due to use of ICT $\geq$ Time for food preparation due to use of existing stove,

Time for food preparation for cooking due use of ICT = 0

ii) if Time saved in cooking due to use of ICT < Time for food preparation due to use of existing stove

Time for food preparation for cooking due use of ICT is,

Time for food preparation due to use of existing stove - Time saved in cooking due to use of ICT

Therefore, total reduced time in cooking activity (includes cooking, food preparation, withdrawing ash) due to use of ICT is,

(Reduced cooking time due to use of ICT + Time for food preparation due to use of ICT + Time for withdrawing ash + Time for fetching water)

Step 3

The objective of this step is to find out the maximum consecutive free hours (i.e., time saved due to use of ICT) rather than having scattered free hours after each meal.

The time for feeding family members will be earlier as it takes place after cooking activity. It will be earlier by a span of time saved due to use of ICT in the immediate preceding hour. This will allow some hours free in the late afternoon to carry out income earning activities. Likewise, other activities can be made earlier until and unless some consecutive free hours are obtained and sufficient for income generation activities.

It should be notable that the schedule will not be strictly followed by rural women. The approach is to find women's consecutive working hours of the day for income generation activity so that women are not over burdened and complete all household activities. Secondly, knowing of maximum consecutive hours would help assess whether some income generating activity during this would be able bring sufficient return to be able to pay back the loan, provide extra income and other associated costs.

5 INTRODUCTION OF IMPROVED COOKING TECHNOLOGY

5.1 Improved Cooking Technology Options

The replacement of the existing cooking stove with the efficient one would be able to provide some hours of the day to generated income from their indigenous skill discussed above.

Different alternative cooking technologies have been considered. Improved biomass stove, biogas and solar cooker can be studied as the options for substitution of the traditional stove (locally known as chula) where indigenous energy sources and materials are used. Since cooking with biogas does not require any continuous observation, use of biogas may reduce the total time for cooking arrangement as it avoids using extra time for fetching water and processing fuels and chopping vegetable. Moreover, biogas, although clean and efficient fuel. However, the resources required for the generation of biogas are not adequate In Polsair village, the average number of cows of large, medium, small and LMF households are 1.33, 1.5, 0.7 and 1.2, respectively. A family of 6 members requires the dung of at least 5 cows to generate biogas to fulfil the daily cooking energy demand (Inter-Consult, 1996). In Hiran village, the number of cows per household is less. However, the existing biogas resources and capital investment (on average 1.2 times more than their annual income) do not encourage the adoption of these technologies.

The concentrating solar collector could be an option currently experimentally tested in Bangladesh by Ananda (1999). But the cost of this collector is too high (ie, Tk. 3,000), about 20% of the average annual income of the LMFs. The cooking time is moderately low as it takes 35 minutes to cook 1 kg rice while it takes 33 minutes when cooking with biogas and even less than both of these by an improved stove (Ananda, 1999 and BCSIR, 2001). The cost of box type solar water heater is about the same price of the improved stove (ie, Tk. 300). But it takes 1.5 hour to cook 250 gm rice. However, our concern is to save time in order to provide income generation opportunities to rural women. The variation of solar intensity does not suggest that the solar concentrator can act as the only cooking technology all along the year. Therefore, the time saved due to use of this technology may not be obtained regularly and thus income generation would be affected.

Most of the households interviewed use one mouth stove. Households usually cook 2 items (ie, rice and vegetables) and use one mouth stove. Rice and vegetable are always common. From their cooking experience

with two mouth stove, the vegetable has been found cooked earlier and so leave one mouth empty while rice is still boiling in other mouth . This causes wastage of fuel and more smokes. The situation will not arise in the case of two mouth improve cook stove as stove is designed in a way that the pan on one of the two mouths of the stove gets heated earlier compared to pan on other. The vegetable will be placed on 2nd mouth away from fuel so that first mouth is not remaining empty and smoke is not coming out. The two mouth stove has been chosen as most of the households cook one single item (ie, mixed vegetable) with rice and 2 items very occassionally.

It has been found that most of the rural women cook two times a day. They are found to cook fish separately thus adding an item to their common 2 items. We in this case consider the replacement of the existing cook stove with 2 mouth improve stove for cooking. From BCSIR's laboratory shows that 39% of the total time for cooking 3 items can be saved due to replacement of the one mouth cook stove by two mouth improved stove (BCSIR, 2000). Three mouth stove is not considered as there is a chance of keeping one mouth empty and there will unnecessary use of biomass fuel. This type of stove has been found to save 75% of the fuel required. This stove has a chimney to avoid three raised mounting points for the pot and this in turn avoids unnecessary smoke coming out from the below the pot.

5.2 BCSIR's Experience

Bangladesh Council of Scientific and Industrial Research (BCSIR) found from their experience that women experienced with the ICS are also giving training to those who are interested in this technology. Women using ICS are found inspired by saving the cost of wood fuel in the semi urban area where gas is not accessible but they have to purchase wood for fuel. They can work inside the house as the smoke goes out through chimney. This reduces their physical drudgery as they are not exposed to heat and smoke.

5.3 Options for the Improved Stove within Women's Daily Work Load

The following steps suggest the opportunities for potential time through the use of ICS (this follows section 4.1). The case of Polsair LMF women also given below:

Step 1: The Figure 1 shows the existing load curve. The introduction of ICS would save both cooking and preparation time for cooking.

Step 2: As feeding of family members follows cooking activities, this time for feeding family members was therefore made earlier by a time slot saved in the preceding hours due to use of ICS. As a result, some other activities have been shifted towards day hours.

Step 3: Personal activities have been advanced for four times until hours in the evening (7 - 8'o clock) has been found to be completely free.
Step 4: Washing and cleaning and agricultural activities have been advanced for 4 times and 2 times respectively in order to free early evening hours from these activities. It has been found that about 55 minutes during 7pm to 8 pm and 34 minutes during 8pm to 9 pm can be obtained as free hours to allow women to work (see Figure 3c).

Again, this routine would not be strictly followed. It just tells if a woman is involved for one and a half an hour of the day, it is not affecting her household activities and also not taking resting time. If rural women are working in a group, the time slot for 1.5 hour income generating activity will be allocated on basis of their mutual agreement.

5.4 Income Generation

It has been estimated that women investing 1.5 hours a night can sew 10 blankets (locally known as '*katha*') a month and would be able to earn Tk. 300 a month at Tk 30 per blanket. If training assistance were available in more marketable designs and in selling their products in the city at higher rate, their wage per cloth may be increased by 10 times. The role of Aarong (in English, it translates as village fair) is recognized most. It was set up in 1978 to help some rural craftsmen market their products. At present, Aarong is supporting more than 30,000 rural artisans – most of whom are women – by linking them to local and international markets. BRAC is an initiative that aims to link rural rural artisan with the urban markets. Aarong sells a katha at Tk. 1500.

It requires at least ten times the work to make an Aarong blanket than the local one. It is assumed that rural LMF women would require a month or 45 hours to do the embroidery work in the blanket. If the labor charge is one third of the total cost of the blanket, LMF women may earn about Tk. 500 or Tk.11 per hour. They would be able to pay back the loan for improved stove and battery on monthly installment basis, electricity bill, and spend on family purposes. Some money will be allocated for the work that would otherwise have been creating drudgery for the rural women. As discussed earlier, the LMF women usually process paddy by themselves to maximize their husbands' earnings. LMFs receive paddy instead of cash payment in the paddy harvesting operation so that they are able get more rice than what they would have purchased from the cash. It is assumed that BRAC will supply them needle and string, clothes.

5.5 Input to Income Generation Activities

Workplace: BRAC as mentioned earlier is an NGO has a well established infrastructure throughout the country ranging from BRAC primary school, micro-credit scheme, BRAC nursery to BRAC renewable energy program (Smillie, 1997). It is preferable to consider local cooperative or club or established body like NGOs functioning in the villages. A BRAC school is located in the center of Polsair village. The school was installed because of the absence of Government school. Extension of a room to this school can be a place for sewing. In Hiran village, there is a established club ' South Hiran Farmer's Welfare Society' which objective is to carry out development activities like skill oriented training, rendering voluntary work during the time of flood, involving unemployed rural youth. One of rooms of club's tin made building can be used for income generating activities. The rent from the room during the night would be club's added income. This cost of renting is considered Tk. 500 per month on the basis of the observation during the field survey.

Electricity : In the case of Muslim village, no electricity for this activity will be required as they existing work load suggest that the day is the most time for this income generating activity. But for Posair village, it will require electricity. It has been estimated that the electricity generated from biogas costs around Tk. 50 per kWh while Tk. 55 for solar electricity. For a given constraint of miro-credit lending capacity for a rural enterprise project, number of buyers from the wealthier group, and resource availability, these electricity prices have been ascertained. As we have determined in the preceding section, they will be working for 1.5 hours from 7:30 pm to 8 pm a day for 4 months during the rainy season. Tables 1a and b show the capital costs and annual operational costs of the project and use of income for different purposes. If the pay back period is 1 year, the saving will be Tk. 7,894 or Tk.1580 per year. After the pay back period, the rural LMF women working there will be the owner of the system. They are not like wealthier group paying 50% down payment in advance.

Table 1a: Costs of the women income generation projects

Capital cost			Operating cost			Grand total
Improve stove	Battery at Tk. 60 per amp-hour	Fluorescent Lamps (8W)	Annual Electricity bill		Annual renting room @ Tk. 500 per month	6,106
			Energy required	Cost		
400	900	3 x 8 W @ Tk. 500 per lamp	6.48 kWh	356	Tk.3,000	

Table 1b: Flow of income generation

Income from sewing				Use of income per annum			
No. of LMF women	pc./month /woman	Wage Tk. /pc.	Grand total	Savings	Loan repayment (50%)	Rent and electricity	Rice husking
5	1	500	15,000	7,894	2750	3,356	1,000

6 IMPROVED STOVE AS AN APPROPRIATE TECHNOLOGY OPTION IN RURAL BANGLADESH

It can now be assessed how far this ICS technology is appropriate following the criteria proposed by Ra.

- Energy intensive: 75% of the fuel consumption can be reduced
- Labour intensiveness : Women from the landless and marginal farmers can be involved in making improved stove. They can make it by hand except stackand then they will be involved in making stoves for others.
- Cost effectiveness: They will be able to repay the loan for the improve cook stove in two years. They will pay it from the income they are generating during the time saved due to use of improve stove.
- Durability: It can be easily maintained easily but requires monthly reinforcement and cleaning of the smoke.
- Ease of operation: It does not require special skill. Since women knows how to make traditional stoves and so a few additional training would be enough for them to learn making this technology.
- Locally available raw material: All materials required to make it can be obtained locally
- Import substitution: The reduced biomass consumption may lessen the pressure on existing biomass resource and future use of the natural gas
- Ecological stability: It helps reduce the use of biomass fuels that can otherwise supply nutrients to the soil.
- Waste recycling: Burns less fuel and thus help putting more biomass residue back to the soil
- Delocalization: As we know from the BCSIR's experience that women's are capable of showing other women how to make this Improve Cook Stove.
- Income disparity : The time saved can be used for generating income and they will be able to pay for husking paddy which is a very physical labor intensive work.
- Socio-cultural stabilization: The existing working environment will be entirely harmonic with the rural culture. Moreover cooking inside the house will enhance maintain purdah norms of rural women as they tend to confront unknown or even known man.
- Local ownership: The trained women are able to offer training and create business. The materials for making the stove are available.
- Sectoral effectiveness: Use of improve stove may create some business of chimneys and also the trained women can earn making ICS for the wealthier households via some NGOs such as BRAC.

7 CONCLUSIONS

The work load of LMF women to perform different household and income generating activities and also the nature of these activities have been investigated to suggest a possible activity where the intervention of appropriate drudgery free and time saving technology can take place. Among all, cooking has been found to be the optimum activity where introduction of ICS saved one and a half hour cooking time along with the creation of tailoring activity during this time slot. With the time resource offered by ICS and LMF women's indigenous skill of tailoring, the income generation project will be able to pay back the loan, provide extra income to pay for overcoming the drudgery for other activity such as rice husking, etc. The use of ICS for income generation activity fits well with two religious groups.

The improved cook stove not only would help empowering the rural LMF women but will help protect natural environment and thereby assist in the goal of sustainable development. According to Diesendorf, "Sustainable development comprises types of economic and social development which protect and enhance the natural environment and social equity".

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