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WOMEN, ENERGY AND SUSTAINABLE DEVELOPMENT

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ABSTRACT

Sustainable development is an equitable, empowering, environmentally sound and economically viable process of growth. Energy is the key indicator of sustainable development. About 74% of the population of India live in rural areas. Eighty per cent of their energy needs are derived from biomass. About 92%of this energy is consumed in cooking activity. Women play a major role in biofuel management. Rural women's perspective in sustainable development is therefore critical. Declining biofuel resources, poor quality of the available biofuels and inefficient devices have pushed women into greater hardships. This paper examines the role of rural women in biomass management and the role of improved cook stoves for the benefit of rural women alleviate rural energy problems and how these cook stoves have benefited women and improved their quality of life to achieve the objectives of sustainable development is discussed in this paper.

INTRODUCTION

Nearly half the world's population depends on biomass for their energy needs and 75% of India's households use biofuel for cooking. Nearly 80% of India's domestic energy needs are derived from biomass. Of the 74% of the total population that lives in rural areas, women constitute nearly 50%. Rural women play a major role in biomass management. Unfortunately information related to women and their role in biomass management is largely based on presumptions. While there is a transition in the energy scenario in urban areas from biofuels to petroleum-based fuels, results obtained by the National Council of Applied Economic Research (NCAER) show that biofuels dominate the rural household energy consumption and continue to stay at 92% [TERI, 1999]. Their choice of alternative developmental strategies and their approach in accordance with their interests, aspirations and talents are essential to achieve the goals of sustainable development in the present millennium. The wood-burning cook-stove is the major cooking device that most rural women use. Traditional cook-stoves have 2 or 3 pot-holes. Traditional fixed mud stoves predominate in rural households. Few households use portable stoves. The design of the stove leads to high radiation losses, thus reducing the thermal efficiency of the stove, which is of the order of 10% to15%. Fuel consumption is, therefore, high in these stoves. Because of this inefficiency the cooking time also increases. Traditional cook-stoves do not have chimneys and hence emit smoke into the kitchen, particularly in the cooking zone. Added to this, the house and kitchen design features, such as low roofing, poor ventilation, and close settlements, aggravate the problem of smoke. Cooking is inconvenient in smoke-filled kitchens. It creates health problems. Biomass fuels emit 6 major pollutants, viz. particulate matter and carbon monoxide, oxides of nitrogen, formaldehyde, sulphur dioxide and benzopyrene. In biomass combustion, exposure to particulate matter is between 17 and 26 mg/hour/m3. It is even higher for dung-cake. In the case of LPG and kerosene exposure to particulate matter is 0.4 mg and 2.4 to 3.6 mg respectively [WHO, 1992]. For every kg of wood burnt, 40 mg of carbon monoxide, 2g of particulates, 1mg of benzopyrene and 200 mg of formaldehyde are emitted [Agarwal et al., 1999].

RESEARCH METHODOLOGY

The dependence of rural women on biofuel is hence increasing. The improved cook-stove therefore receives the topmost importance and priority today. Number of studies conducted within the country and abroad suggests that there is need to design energy efficient and environmentally sound improved cook stoves for fuel saving and minimization of indoor air pollution. process heat

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and decentralized power generation.

Our university has developed a double pot improved cook stoves having about 25 per cent thermal efficiency. It has been estimated that about 950 Kg of fuel wood can be saved through one cook stove in a year. There is consideration saving on fuel wood and pollution reduction through this technology. This project is having direct bearing towards petroleum conservation, energy conservation and pollution reduction. It is well defined fact that about 3 ton of fuel wood saving is equivalent to one ton of liquid fuel. Presently installed target of 3000 cook stoves is having saving of about 920 ton of oil equivalent of biomass per year. Further, tendency of beneficiaries towards switching over LPG and kerosenefor meeting cooking energy will also be controlled.

Work done in this project:

a) Organization of trainings in rural areas for dissemination of technology.

During this period attempts have been made to disseminate the technology among villagers. In this context, numbers of trainings were organized to elicit the importance of the present technology involved and advantages of system in long run.

b) Establishment of prototype of improved cook stoves in the village level as demonstration units.

As mentioned above one or two models of improved cook stoves have been constructed and local masons were trained during training. After that local trained masons constructed the cook stoves in their respective villages.

c) Establishment of improved cook stoves in the village level on cost sharing basis.

PCRA has given a total target of installation of 3000 cook stoves in this project in different places. Previously, 1065 cook stoves were installed, after that 1244 cook stoves were installed reported in previous two reports. After that period total 720 more cook stoves were constructed at different villages on cost sharing basis.

Emphasis was made towards installation of improved cook stoves in the rural areas after exposing the advantages of double pot energy efficient and environmentally sound cook stoves to the beneficiaries. Few demonstration units were also laid in the rural areas to demonstrate use of improved cook stoves and simultaneously farmers were explained its advantages. Total fuel wood saving and extent of minimization of indoor air pollution is also accessed.

RESULTS AND DISCUSSION

a) Salient features of improved cook stove

The special feature of this improved cook stove is bigger size of fire-box, which is suitable for big size firewood and light agro-waste type of fuel. The diameter of the 1st pot is 24 cm, which is suitable for maximum households for baking of "Chapatti". The diameter of 2nd pot is 20 cm and suitable for cooking vegetables and boiling of milk etc. The burning of wood is very efficient without backfire. The improved cook stoves produces minimum amount of smoke on account of complete combustion and remove smoke safely. This improved cook stove works with an average thermal efficiency of 25 per cent at the fuel-burning rate of 1.0 kg/hr. It has been designed on the basis of principles of complete combustion. In order to burn one kg of fire wood per hour about 5 cu. m. of air is required. A mixture of cement and sand is used to fix up the bricks. After this, plaster is made on the outer surface of the cook stove. A metallic mould set has also been developed for quick and accurate installation of this improved cook stove in the field (Table 1).

Table 1. Specification of UDAIRAJ Improved Cook Stoves

S. No.	Name of Body Part	Particulars
1.	Body material	Brick masonry with cement plaster
2	Major dimensions	
	(a) Body	850 mm x 400 mm x 250 mm
	(b) Fire box	First pot dia. 240 mm & second pot dia. 200 mm.
	(c) Fire box opening	240 mm x 160 mm
	(d) Tunnel	Diameter 2.5” First pot to second pot-100 mm length Second pot to chimney-80 mm length

Line diagram of "Udairaj" model is given in Fig 1 which illustrates complete specification of the system with its front and side view. In case of the double pot community cook stove, a connecting tunnel is also provided for flowing fire from the first pot to the second pot (Table 2).

Table 2. Specifications of the materials used for construction

S. No.	Material	Important Specifications
1.	Bricks	Good quality first class bricks with uniform size and shape preferably machine made
2.	Cement	Pure Portland cement with no impurities, packed in polythene bags
3.	Sand	Fine & Coarse with good quality
4.	Asbestos-cement pipes for removal of smoke	Good quality with no cracks and should have uniform diameter and length as required.

Emphasis was made towards installation of improved cook stoves in the rural areas after exposing the advantages of double pot energy efficient and environmentally sound cook stoves to the beneficiaries. Few demonstration units were also laid in the rural areas to demonstrate use of improved cook stoves and simultaneously farmers were explained its advantages. Total fuel wood saving and extent of minimization of indoor air pollution is also accessed. The performance of Udairaj (Double pot) was carried out by standard water boiling test. The sun dried Acacia nilotica (desi babool) wood having calorific value of 3700 Kcal/ kg was used for testing. This was used at the rate of 1 kg/ hr. The result of water boiling test is given in Table 3, which indicates the thermal efficiency of Udairaj is as 29.86 per cent (Average value). A standard thermal efficiency test approved through Ministry of Non-conventional Energy Sources, Government of India was followed for conducting the experiment.

- Model: UDAIRAJ (Double pot)
- Type of fuel used for testing: Acacia nilotica (Desi Babool)
- Time taken: 1.5 hr.

Table 3. Thermal Efficiency of Durable Improved Cook Stoves

Model of Improved Cook stove	Quantity of water taken (lit.)	Quantity of water evaporated (lit.)	Burning Rate (kg/hr.)	Thermal efficiency (%)
I pot	5.00	1.70	1.00	29.37
II pot	3.00	0.55		
I pot	5.00	1.75	1.00	30.34
II pot	3.00	0.60		
				29.86

The comparative scenario of efficiency of cook stove is given in Table 4. Which revealed that, thermal efficiency of traditional cook stove was found to be 10 per cent as compared to the improved cook stoves where thermal efficiency was observed as 22.05 per cent, which is 12.05 per cent more than the traditional stove. This indicates there is direct saving of fuel wood through use of improved cook stoves. Since it is based on complete combustion of fuel wood therefore there are minimum chances of emission of harmful effluent.

Table 4. Thermal Efficiency: Comparative score of Traditional & Improved Cook stove

Type of Cook stove	Thermal Efficiency (in percentage)
Traditional Cook stove	10.00
Improved Cook stove-Udairaj	29.86

b) Mean Saving of Fuel and Time Consumption

Cooking for the Indian homemakers is still a full time occupation, yet, unfortunately not much attention is given to its efficiency and environment. Effectiveness of various activities in the kitchen depends mainly upon the efficiency of cook stoves used for cooking. It has been observed that working flack spend 6-7 hours per day in cooking alone. Hence, besides giving a number of other socio-economic and medical benefits, the improved cook stoves based on energy efficiency and environmentally sound helps in minimization of indoor air pollution, reducing fuel wood consumption in performing cooking operations & improving work efficiency of rural women and ultimately saving in the national bank of liquid fuel. Improved cook stove is not only helpful for

increasing thermal efficiency of biomass combustion of about 25 to 30%, but also a means for safe removal of smoke and other inert gases out of kitchen, which are main causes of indoor air pollution. Table 5 illustrates that the mean saving for fuel and time consumption. In cooking each meal with improved cook stove the mean saving of fuel was found 71.43 per cent. Similarly, there is a saving of 62.26 per cent time spent for cooking each meal in comparison of traditional cook stove which can be utilized further in more productive work.

Table 5. Mean Saving of Fuel and Time Consumption

S. No.	Fuel and time consumption	Mean Saving (%)
1.	Fuel consumed in cooking each meal	71.43
2.	Time spent for cooking each meal	62.26

The work on installation of the improved cook stoves was made at user's level in selected cluster of rural households on cost sharing basis and subsequently evaluation field level performance in terms of fuel saving and minimization of indoor air pollution was also made. This was followed by conducting benefit/ cost analysis of designed cook stoves at field level. The saving in cooking fuel, reduction in the indoor air pollution level and efficiency of cooking devices was made in actual level after installation of improved cook stoves.

CONCLUSION

This project included selection of farmers interested in this technology, installation of improved cook stoves and performance evaluation & economic analysis of the installed systems. The efficiency of cook stoves was measured in actual operation at number of places which indicates about 26 % thermal efficiency for domestic double pot cook stoves. In five selected villages study on indoor air pollution was extended and better health status of beneficiaries using improved cook stoves was observed. It is estimated that on an average 950 kg of fuel wood per domestic cook stoves per year was saved. The introduction of improved cook stoves has also reduces the burden of collecting fuel wood and saving in overall energy bill of the individual family. Now many villagers are coming forward to integrate improved cook stoves for meeting cooking energy requirements.

Environmental compatibility/ sustainability:

It is observed that a technology or package of practice for utilization of improved cook stoves at village and community level is transferred. End users of improved cook stoves were different villagers and application was for meeting cooking and process heat requirements. Improved, energy efficient and environmentally sound improved cook stoves were designed and commissioned at various villages to reduce conventional fuel consumption, pollution level and minimize energy bills through improved cooking methods. The performance evaluation was made in terms of saving in fuel wood and extent of minimization of indoor air pollution. It is estimated that at least 10 tonnes of CO2 reduction was observed at one farmer's level in one year through one unit. Thus total expected reduction was about 1912.7tons per year from a cluster of installed units. It is observed that villagers prefer Udairaj model as it is unique in feature and having higher thermal efficiency with double pot arrangement. Further, these improved cook stoves were designed keeping in view of requirements of air for complete combustion and there by proper draft was maintained which eliminate smoke in the rural kitchen and users were happy to get rid of smoke problems. One of the most important driving factors is the fuel consumption, which drastically reduced as quoted by users. It is observed that about 950 kg of fuel wood can be saved annually from one such cook stove.

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