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Impact of appropriate cooking stove technologies on rural women

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Abstract: Rural households depend on clay stoves called chulhas for the purpose of cooking food. In the chulhas, biomass inputs are used as fuel. Families living in the rural areas depend on biomass inputs since it is available free of cost. In general a family of 5 to 6 persons require about 8 kg of fuel per day. The domestic fuel used comprises of agricultural residues, twigs, cattle dung, and wood particles which constitute about 40% of the total mass. This biomass consists of waste materials generated in the family farm and wood particles collected from the surrounding environment in the neighbourhood.

Though Burning of biomass fuels pollutes the air and the environment, biomass fuels are largely used for cooking food, heating and sometimes lighting in the rural areas. Finding the large availability of biomass in the environment more than 90% of the families use biomass based chullahs for cooking purposes. Though the inputs used are cheap and locally available, use of traditional chulhas has certain disadvantages. Firstly it can bring only 10 percent of the total heating potential of the fuel into use while the rest of it goes waste. Secondly traditional chulhas produce a lot of smoke, soot and unburnt volatile organic matter; this blackens the cooking vessels and also the surroundings like walls of the kitchen and pollutes the indoor air affecting the health of the family adversely. Thirdly women and small children are constantly exposed to the burning fuels and become victims of pollution as these people are found working within its vicinity all the time. As per the medical reports and major health studies, continued exposure to such an environment leads to lung infection, eye and skin infections.

In order to overcome these disadvantages which have serious consequences on the health and reduce the exposure to such harmful effects, the available interventions include changing the cooking practices and building awareness on the impact of such exposure to smoke on health of women. Subsequent to some interventions made by civil society and government agencies by introducing innovative cooking stove technologies, yet the technologies are not accepted for application as a result could not penetrate neither the mindset nor the kitchens of the rural folk as social, cultural and financial constraints are seen as major challenges to gain a breakthrough.

Key words:

Appropriate Technologies- application of small-scale, labour-intensive, energy-efficient, environmentally sound, and locally controlled technologies, Appropriate Rural Technology Institute (ARTI), Briquette- waste material is pressed into compact briquettes.

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1.0 Introduction

Today in India, nearly 70 percent of the population live in the rural areas of which 50 percent constitute the women. Tradition rules that women are the home makers and it is their responsibility to cook and provide food for the family. As per these traditional expectations, women spend more than 20-30 percent of their time every day on cooking food. Rural India attends to this need through the use of most traditional means where the woman of the house squat on the floor lighting the fire using biomass fuels like dried and baked animal waste, wood, dried twigs etc as inputs into the stove and keeps blowing air on to the fire until it catches flames. Gradually with the combustion of the biomass the smoke is emitted and the woman continues to work in the same premises attending to other needs of the family like mixing the dough, flattening the roti's, cutting the vegetables or cooking in general. Even though the fire catches below the cooking dish, it needs to be fanned frequently to regulate the fire and monitor the burning process lest the fire succumbs. In the event, it demands continued presence of the woman in the vicinity of the stove, thereby exposing her to the smoke emitted from the stove. Along with the women, little children also hang around the place where the cooking stove is located.

In the garb of this understanding the paper is written with the following objectives;

1.1 Objectives of the paper;

- To highlight the harmful effects of smoke on health of women and children
- To provide an alternative solution for appropriate and safe cooking technologies.

1.2 Impact of Traditional cooking technology on the health of women & Children

The household rural technology that is currently used for cooking is very archaic and is haphazardly or-

ganized by placing three stones in a triangular position with enough of space in between to place the twigs and biomass material for burning. Most often, food is cooked on inefficient cooking stoves in closed areas with no ventilation. Use of such technologies emit noxious and hazardous end products. These toxic substances upon combustion from the stove and diffusion into the surrounding atmosphere are observed to lead to major health disorders like acute chronic respiratory diseases, burning of eyes, eye disease, low birth weight in the new born and infant mortality. The chemical emissions from the smoke range from sulphur dioxide, carbon monoxide and polycyclic hydrocarbons which have a potential for creating carcinogenic effects on the health of persons who are exposed.

On the other hand continued demand for biomass fuel is also placing a pressure on the forest and woodlands with the rural populace cutting the trees, contributing to deforestation and soil erosion. The demand for wood is so great that even young trees are harvested as inputs for fuel. Statistics (world over) reveal that around 3 billion people rely on wood, dung and leaves as fuel for cooking and nearly eighty percent of rural women use biomass to cook their food.

Till now many studies have been conducted on impacts of burning biomass fuel in the open and the use of inefficient stoves however a review of literature establishes that there are many disadvantages in the use of biomass based fuels such as; release of many harmful pollutants and (1) inhalation of these pollutants has led to respiratory morbidity and mortality in women and children. (2) Perceiving the harm that these pollutants cause to human beings upon prolonged exposure these pollutants are named as "silent killers"(1) as they slowly damage the health over a long period of time. Thus prolonged illness associated with fever and cough is usually seen in most of the rural women who have no reason to explain their illness. Gradually women lose health and are unable to think and are not active by themselves and will not be able to do much work. This is the reason women suffer from loss of human capital and instances of prolonged illnesses are evident which hamper women's active participation in livelihood development. More than women, statistics also show that over 1.6 million children die annually in the developing countries due to their exposure to smoke generated from burning biomass fuel (2). An exposure to the smoke leads to acute respiratory infections (3) chronic obstructive pulmonary disease (COPD) (4) and lung cancer (5) in women. In Ethiopia, higher amounts of carbon was observed in women and children who were exposed to biomass smoke. Exposure to biomass smoke is thus a very serious issue and can be considered as a major public health hazard in the rural areas (6)".

Thus traditional chulhas do not serve the purpose of cooking in totality as they use only 10% of the total heating potential of the fuel burnt in them. Another disadvantage of the traditional chulhas is that they produce lot of smoke, soot and unburnt volatile organic matter which not only blackens the vessels and the walls of the kitchen but also pollutes the indoor air and adversely affects the health of the householders.

Interventions to improve or bring the domestic cooking stoves into utility are resisted by the rural population since they view the traditional means of cooking to have some health benefits which have not be proven scientifically.

In consonance with the inferences of various studies conducted till date, appropriate technologies which can facilitate safe cooking practices utilizing affordable and cleaner fuels on improved cooking stoves is the only solution. Cooking stoves designed with improved means to reduce pollution by reducing indoor air pollution are available in the market

They can also be built by giving proper attention to design and quality. At the same time adequate care should be taken to enhance understanding on the usage of the technology either through training or a demonstration effect.

Lack of awareness on availability of such improved cooking stoves and its usage constitutes another barrier in the acceptance of technology. Therefore educating the women on the available technologies and also on the effects of using such technology interventions is essential. These technologies may differ from place to place and region to region and may be specific to particular areas which are termed as Appropriate Technologies.

2.0 Appropriate Technologies for improved cooking systems

Improved cooking stoves play a vital role in reducing the drudgery and promotion of social, economic and health status of women utilizing the traditional stove in the house. This also empowers rural women to concentrate on other economic activities and the family by permitting more time to them. The improved stoves also benefit the women by not only protecting their health but also help in participating in our efforts to reduce pollution. Use of appropriate technologies play a very effective role in promoting the improved cooking stoves and also overcoming the crisis.

Thus understanding on the concept of 'Appropriate Technologies' is emphasized by its proponent - Schumacher as, people-cantered and generally recognized as encompassing application of small-scale, labour-intensive, energy-efficient, environmentally sound, and locally controlled technologies.

Today a large number of organizations are involved in research, design and development of a wide range of improved cooking stove models in various capacities, costs, technology and efficiency. These stoves are so designed that they are affordable for purchase by the rural poor. And the biomass products such as cow dung or wood as inputs to generate fire can continue to be used with lighter efficiency. Only improved Biomass Stove with improved efficiency will help in reducing the consumption of fuel wood up to 60 percent and also lead to the restoration of forests. Use of these improved stoves also reduces the time spent on cooking by 50 percent and the time so saved can be spared for improved productivity. At the same time it leads to reduced in-door air Pollution (IAP) and Improved Health. But, all such technologies are resisted by the rural poor since the fire wood is available in abundance in the forests and the women have drawn a line of comfort around themselves by adhering to the traditional means of cooking. Lack of awareness is also another reason for such resistance. However, tradition and mankind has never given a serious thought to its impact on women and so women have been using those proven technology for preparation of the food. Against existing knowledge on use of traditional cooking practices a review of various improved cooking stove technologies has been made and based on it the following technology models are discussed with implications for potential dissemination and adaptation.

2.1 Appropriate Rural Technology Developed by ARTI

Appropriate Rural Technology Institute (ARTI) has produced a better quality fuel from agricultural waste and also stoves and furnaces that burn the biomass more efficiently and are considered as clean. Appropriate cooking systems including the cooking stoves and the fuel are the important constituents in promoting safe cooking practices for women. ARTI, instituted in Phaltan, Satara District of Puna, has made some innovative intervention in containing the problem and addressing the issue of pollution, health and welfare.

SARAI cooker and Char Briquettes stoves have been developed by conducting research and development activities on a concerted basis. Today it is able to provide cooking stoves to the poor which are economically and technologically viable. This is a very simple technology, a non-pressurized cooker in which char briquettes are used as fuel. The cooking system has a stainless steel body with a built in charcoal brazier. The brazier takes 150-200 gm of the briquettes per one time cooking. The vessel has a sequence of 4-5 boxes placed one above the other for inputs meant for cooking. Foods like Rice, Dal, Vegetables and even Meat can be cooked in this cooker. In the last box the char briquettes are placed and above it all the other boxes are placed one above the other. The briquettes in the box are lit with a match stick and the boxes with the raw materials to be cooked are placed one above the other and is closed. It takes about an hour to cook the food for a family and it can simply be left to cook by itself and the food remains warm up to two hours. This cooker burns only 100 g of char briquettes to cook the meal for 4 to 5 persons. In this technology there is no burning or charring of the food, and the stove turns itself off as soon as the food is cooked. So there is ample scope for the householder to attend to other works during the time. And this is a portable technology; it can be carried to the work site by the workers. The cooker costs Rs.1000/-.The main attraction of this stove is cost effectiveness and fuel efficiency. Nearly 5000 families in Pune today use Sarai cooker on a daily basis.

2.2 Economic & Environmental Benefits of using ARTI - SARAI Cooker

According to the scientific assessments on the use of the Sarai char briquette stove for cooking dal and rice on a daily basis, the family will be able to save about 250 gm of LPG or 0.5 lit of kerosene. And this would mean that the family is able to save Rs.5 per day on LPG and Rs.10 on kerosene usage. And the monthly saving amounts to Rs.150 for LPG and Rs.300 for kerosene. On the other hand, burning of 1 kg of LPG releases 3 kg of CO2 equivalent GHG in the environment. (According to: UNEP, 2000).

Thus use of Sarai means:

- Avoiding 750 gm of CO2 equivalent of pollution every day and
- Avoiding 22 kg of CO2 equivalent of pollution per Month and
- Burning of 1 lit of kerosene releases 2.6 kg of CO2 equivalent GHG in the environment. (Source: UNEP, 2000)

The improved cooking stove technologies so handed over to women demand use of briquettes as fuel. They are sold at a rate of Rs.16 /- per Kg, thus Households do not want to spend money for the briquette input when biomass is available in the surroundings.

Thus improved cooking stove technologies have remained as sophisticated systems of the rich and not the poor who use it for table baking of the food. Therefore the adoption of and transfer of such new & improved cooking technologies has a long way to go in achieving health and sustainable livelihoods for the poor.

The price of the briquettes can be brought down by adopting the briquette making technology for income generation activity.

The briquettes used in the SARAI cooker called as the briquetting technology using the agricultural waste has been developed by ARTI. These briquettes are also used as fuel in cooking stoves. Going by the scientific reports, agricultural waste has a calorific value of about 4500

kcal/kg, which is similar to wood, but because the density of the agriculture waste is low, it cannot be used as fuel in a stove or a furnace. In order to increase its density, the waste material is pressed into compact briquettes. In this process, the lignin in the biomass gets liquefied under pressure and acts as a binder. Because the process requires generation of high pressure, it needs heavy equipment and high energy to produce them. One disadvantage of transporting the Agricultural waste is that it has to be transported from the farm to the factory and transporting such light biomass to a central processing factory is not always economical. Therefore producing the briquettes at the site is not only economical but also creates income as livelihood opportunities to the rural poor.

Secondly, charcoal produced from woody biomass is an ancient technology. In this process, the volatiles in the biomass are removed by infusing them in high temperature. After this process bout 30% of the biomass is left behind in the kiln as charcoal.

Agricultural waste was never considered as raw material for making charcoal, because it is light and powdery. ARTI developed a process for charring the light biomass and making charcoal briquettes out of it. In order to avoid transporting the light biomass to the charring kiln, ARTI uses portable metallic kilns, which are taken to the site where agricultural waste is available. The char powder, which weighs only one third of the original biomass, is then transported to the briquetting factory to produce the charcoal briquettes. This is considered as a highly remunerative business, if raw material is continuously available during a period of about 8 months and if four persons in a family are engaged in this enterprise, they can earn Rs. 1, 00,000 to 1, 50,000 in this period.

2.3 Other Cooking Stove Models

Subsequently many other models have been developed by ARTI based on research. An overview of other cooking stove models gives an inventory of models which has been developed by using locally available material that are cheap and environment friendly. While designing these improved Chulas care has been taken in considering flame characteristics of chullah.

Firstly the height of the Chula is adjusted so that the center of the vessel comes in contact with the hottest part of the flame. Secondly, the grate an important feature of the improved Chula which provides sufficient air to the burning biomass is adjusted and placed in the centre.

Thirdly, when the flame emerging from a concentrator hits the bottom of the pot at its center, enough of space is created for it to spread out towards the periphery of the pot. This mechanism increases the area of contact between the fire and the cooking vessel and this contact brings down the cooking time resulting in better transfer of heat from the flame to the pot. The collective effect of this technology results in increasing the efficiency of the Chula to 30% and also helps remove fuel gases and smoke out of the house.

Construction process of the Chula

Usually Cement concrete is used for fabricating the Chula. Cement Chula with two holes to support two vessels requires 7 kg Portland cement, 22 kg stone grit and 16 kg stone powder. Adequate water to make a mix of the cement mortar. Ideally, the chulhas are fabricated in workshop and then installed in the kitchen. The new Chula requires to be dried out completely and in case of cement Chula curing of cement concrete is required. For clay and cement concrete the Chula also require a grate. A Chula with chimney is made out of the asbestos – cement pipe and terracotta cowl. The chimney would also require additional accessories. The mould consists of several removable parts made out of iron sheet and steel rods and the process involves filling of the mould and incorporation of individual parts in to it which are all conducted in a sequential manner. The process of construction of these models is very simple.

2.3 (A) 1) **Chulhas developed by AARTI**

Following is the description of the models of improved chulhas developed by AARTI and various other agencies.

1) Laxmi chulha

Figure - 1 Laxmi chulha

This Chula is produced with an objective to accommodate two cooking vessels at a time wherein one vessel gets 60% distribution of heat while second one will get 40 % of the heat. A chimney is also a part of the system. Cooking vessels can be placed directly over the stove and biomass can be fed from the bottom. Conse-

quently the emission of fuel gases can be reduced in the kitchen.

2) Bhagya Laxmi

Figure – 2 Bhagya Laxmi

This stove is similar to the Laxmi model but it is devoid of the chimney.

3) Grihalaxmi

Figure – 3 Grihalaxmi

This is a cooking stove facilitating the mount of a single vessel and it to does not have a chimney. It is provided with a top grate which acts as a flame concentrator.

4) Improved Laxmi Stoves

In order to meet the international standards and the Internationally accepted norms of emissions from the stove , ARTI has recently improved the design of the laxmi stove by providing a cast iron bottom grate for all the models discussed above and these stoves are called as improved laxmi stoves. The durability assessed for these stoves is between 3 to 5 years.

2.3 (B) Solar cooking stove

Another model developed by an NGO named Rural Energy Centre located in Nellore uses the solar panels of 10 watts to fan the flame under the stove which is fed with the biomass and wood based fuel inputs. In this technology the solar panel is connected to the fan inside the cooking stove.

Once the fan switches on, the biomass catches fire and with continuous fanning, the flame in the stove is regulated for cooking food. This technology also speeds up the cooking time and large scale cooking can be organized reducing the drudgery of cooking. The major benefits include cost and time effectiveness, reduces pollution and reduced risk of pollution for women.

2.3 (C) Solar Box Cooking Stove Model

This is a box cooker model, in which the cooking material is placed in the box which is lined inside by insulating material and is covered on top with a glass. It is then placed under the sun for the cooking process to activate. Reduced air and environmental pollution are its major benefits.

2.3 (D) The Shafflers Cooking Stove Model

Figure – 4 Shafflers Cooking Stove

This is another cooking stove technology which is again based on the solar energy technology in which a concentration of mirrors is placed on a parabolic concave lens model. And when the sun rays fall on the mirror, the concentration of the rays is so adjusted that they reflect towards a point at which the vessel for cooking the food is placed and the food is cooked subsequently. This model is used by the Social Work Research Centre in Tilonia, Rajasthan. On similar principles the mirror based technology is followed where ever there are larger scale cooking requirements.

In another model when the sun rays fall on the concave mirror the rays are directed on to an aluminium pipe through which the water flows and upon exposure to the sun rays the water gets heated instantaneously. And this hot boiling water is run through the food grains in a vessel and when left for few minutes the food gets boiled immediately. This technology is used to cook food in religious monasteries like Tirupathi and also in the army camps.

In addition the solar heating systems are available to heat water through similar solar systems.

2.3 (E) Compact biogas plant

Compact biogas plant is a novel technology developed by ARTI. It uses food waste (sugar, starch, proteins, fats, cellulose) as feedstock. This category of material gets completely converted into biogas upon stagnation for 3-4 days. Therefore, feedstock of one kg dry weight would produce one kg biogas, containing about 250 gm of methane. This biogas can be used not only for cooking but also as fuel in an internal combustion engine, replacing petrol or diesel. In this system there is a utilization of methane and this does not produce any soot or smoke, It is an environment friendly technology where in wet waste from the households is utilized. Maharashtra state has about 5, 00,000 users of this technology.

3. 0 Conclusion

These technologies help in preventing millions of premature deaths of women and children due to indoor air pollution caused by the traditional Chula's. At a global level such technologies replace the exploitation of the fossil fuels reducing the emission of green house gases.

Such a host of cooking stove technologies are available in the market which adopt the concept of appropriate technologies, but are not sustainable as people find it easy to revert back to the traditional systems without realizing the physical and health impacts.

Even though women in the rural areas show their willingness to shift to improved methods of cooking they will not get a backing from the other households as they will not be able to afford an improved system since they are able to make do with cheaper technologies with easily available biomass inputs. Secondly, lack of knowledge, awareness and education have been cited as factors for the failure of promotion of improved cooking stoves. For example, the Indian National Stove programme, (1985-2002) the Indian Government installed over 30 million improved cooking stoves. Within two years most of the users had reverted back to traditional cooking methods. Lack of awareness and education was noted to be one of the reasons for the failure. Therefore in villages where the level of knowledge and education about indoor air pollution is low, physical interventions should be accompanied by appropriate education to enhance the long-term sustainability of stove programmes.

Social marketing is another intervention through which ideas, attitudes and behaviours can be "sold" to people. This is a concept used in economics and is created in the 1970s by Kotler and Zaltman. Manufacturers of cooking stoves and NGOs have used this technique to promote healthy cooking methods and the arguments used by this community were to promote dissemination of the technology but it rarely gave out the messages which relied on health instead in its lieu the messages emphasized on the benefits in terms of reduced cooking times or cleanliness in the house. Apart from all this advocacy promotion of simple measures such as cooking outside the premises of the house, keeping the children away from being exposed to the smoke and better ventilation facilities need attention and advocacy.

But it is also useful to know if any of the households had heard about the different types of stoves that are available and if yes whether they had been approached by any organisations in transferring the technology.

Improved Biomass Stove with improved efficiency of 60% will help in Restoration of Forests and reduce the dependence on Fuel wood up to 60%. The time spent on cooking will also be reduced up to 50% with improved productivity and reduced In-door air Pollution (IAP) leading to Improved Health. Therefore increasing awareness on the health-effects of indoor biomass cooking smoke is the first step in implementing a programme to reduce such exposure of the women. The aim of all community based organizations should be directed towards the implementation of programmes to increase accessibility and use of improved stoves in the area, along with appropriate education.

Further research needs to be taken up to dovetail and help ensure an evidence-based approach of the post-implementation evaluation of health and awareness impact of the improved stoves.

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Biographical Sketch

I am **Dr.G.VALENTINA,** My Educational Qualifications are M.A,M.Phil, Ph.D, in Sociology and IRPM & PGDEE from Hyderabad Central University, Telangana, India. I earned my doctoral degree in the year 2002 and presently working as Assistant Professor at the National Institute of Rural Development, Government of India Organisation, under the Ministry of Rural Development. Also worked as Faculty at Hyderabad Central University and put up more than 5 years of teaching Research Methods and Sociology of Gender, Industry, Development etc for post Graduate students (Masters). Sub-

sequently working in National Institute of Rural Development, Government of India organization under Ministry of Rural Development and been working here as Assistant Professor since the past 12 years.

Academically, been involved in Training middle and senior level functionaries. Conducted training Programmes at National and international level and has been a resource person for more than 100 training programmes, involved in research studies and action research projects dealing with poverty eradication and rural development with implications for policy analysis and Published many articles

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In Action Research, principally involved in transfer of Solar Energy Technology in Rural Tribal Areas and participated in International seminar on Renewable Energy Technologies in Tokyo –Japan, and undergone one month International Exposure & Training Programme on 'Leveraging Community Assets for Social & Economic Development in Israel.

Initiated the programme on 'Post Graduate Diploma Programme in Rural Development Management' (PGDRDM). Conducted workshops on Curriculum Development & Curriculum Finalization, Development of Study Material, organised Placements and produced unique curriculum for effective and efficient management of the programme. Also worked for the International Project launched by UN WOMEN on leadership development for women elected representatives, developing training modules and training middle and senior level officials working with elected women representatives.

Developed expertise in Management of Academic Programmes like Sustainable Livelihoods for poor, Transfer of Solar Energy Technologies in rural inaccessible areas, Gender Concerns, Gender Budgets, Gender Mainstreaming, Human trafficking, Renewable Energy Technologies, Appropriate Technologies, Entrepreneurship Development etc. and Gained ample teaching, training, research, action research and managerial experience.

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