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Research Article

Improved cooking stoves as an eco-friendly practice for reducing fuel-wood and CO_2 emission: A case of Meghauli, Chitwan, Nepal

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Abstract

The energy demand is ever increasing with the growing population with increased consumption and living standard. In the developing country like Nepal, traditional sources of energy such as fuel-wood, dung and agriculture residues are still in use. Such a traditional energy sources and cooking practices have several environmental and health implications. The present study was carried out in Meghauli Village Development Committee of Chitwan districts in which attempts have been made to assess the status of Improved Cooking Stoves (ICS) and its contribution in reducing firewood consumption, carbon dioxide (CO_2) emission that help saving time and lessening women drudgery in household work and ultimately reducing climate change impacts. Moreover, health status of the people was also undertaken. For the purpose, household survey method was applied for gathering the information. The results showed that ICS to be more efficient compared to the traditional cooking stoves. The average firewood consumption for household purpose prior to installation of ICS was found to be 310.62 kg/month which reduced to 253 kg/month, i.e. 57.62 kg less in a month. This helped to reduce CO_2 emission by an average value of 105.44 kg/month. It has also been reported that there was substantial (262 hours in a year) reduction in time consumption for household work. However, yet higher number of people (11.63%) was found suffering from respiratory and eye diseases probably due to biomass burning and other labor based works.

Key Words: Biomass, Carbon Dioxide Emission, Climate Change, Improved Cooking Stoves, Respiratory Problems

Introduction

The energy demand in the world is steadily increasing and the much of the demand is fulfilled with non-renewable energy such as coal, gas and oil. However, traditional sources of energy are still in use for domestic (cooking and heating) purposes in developing countries. Nevertheless, having a greater role of fossil fuel bur ning in industrialized and developed countries for climate change, the biomass buming particularly for household purpose is also contributing for Green House Gases emission and causing climate change (World Bank, 2010). Furthermore, forest degradation is an utmost result from biomass bur ning or use of traditional energy resource in rural areas of the developing countries, which finally deplete the sinking area for emitted CO_2. The net global deforestation rate has been averaged 7.3 million hectares a year, from 2000 to 2005, contributing about 5 giga tons of CO_2 per year emissions (W orld Bank, 2010).

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Nepal relies heavily on traditional energy resources, as no significant deposit of fossil fuel are available (CRT/N, 2005). Lack of fossil fuel deposition and a smaller amount of hydro-electricity generation has compelled to use biomass resource such as firewood, animal dung and agricultural residue, which accounts for 87.1%. In totality , firewood occupies about 78% of the total energy consumption (WECS, 2010). With increasing population and fuel price of commercial energy, there is an increase in demand for firewood in the country, as it is cheaper and easy to obtain.

Reduction of CO_2, increased carbon sequestration and carbon substitution are the major activities for mitigating the impact of climate change. Among others, adoption of eco-friendly practices such as use of Improved Cooking Stoves (ICS) are supportive for reducing climate change impacts and also benefitted to the vulnerable r ural people and women

household workers to adapt with climate change and reduce CO_2 emission. ICS is becoming one of the widely adopted rural technologies in some rural parts of the Nepal (Khanal & Bajracharya, 2010). Women are mainly responsible for cooking activities and collecting firewood. Hence, greater efficiency of ICS (15-25%) and saving of fuel-wood help reducing the women drudgeryof women, since ICS cuts down their cooking time and hardship in collecting firewood (CRT/N, 2000).

Materials and Methods

Study area

Chitwan district covers an area of 2218 km^2 and lies within the Siwalik belt in the Western Development Region of Nepal. This district is rich in cultural diversity and ethnicity, having diverse geography and tropical monsoon climate. The Chitwan National Park lies toward south central Nepal, which spreads over 932 km^2 and surrounded by Buffer Zone (BZ) area of 750 km^2. The BZ area is bounded by Narayani-Rapti River system in North and West, between South-Eastern boundary of the park and the inter national boundary of India.

The present study was carried out in Meghauli VDC of Chitwan district which lies within the Buffer Zone area of Chitwan National Park (Fig. 1). In totality, it covers an area of 30.46 km^2. Its access is 26 km south from Narayanghat city. Total number of households in this VDC is 3,086 and total population is 14,149 consisting male 6,341 and female 7,808 (CBS, 2012).

Data collection and analysis

Primary and secondary information were collected from field visit, published and unpublished data resources, so as to get more qualitative output. In response to get the first hand data field survey was conducted on 15 - 20 July, 2010. During field visit, the ICS installed houses were listed with the help of key informant such as ICS promoter, VDC chairperson and BZ management chairperson. In totality, 900 households were found with ICS installation in their kitchens for cooking.

Household questionnaire survey was done for gathering the primary information and simple random sampling technique was used to select the sampling households. In order to determine the sample size, a simple formula given by Arkin and Colton (1963) was used; which can be represented as;

$$\text{Sample Size (n)} = \frac{NZ^2 P(1-P)}{Nd^2+Z^2P(1-P)}$$

Where,

n= Sample size (68)
N= Total number of households (900)
Z= Confidence interval (at 95 % level, Z= 1.96)
P= Estimated population proportion (0.05)
d = Errors of limit of 5 % (0.05)

A total of 86 ICS user households were visited for the survey. The questionnaires were prepared by accompanying the issues of socio-economic behavior of the inhabitants, energy consumption, health status and perception of local people

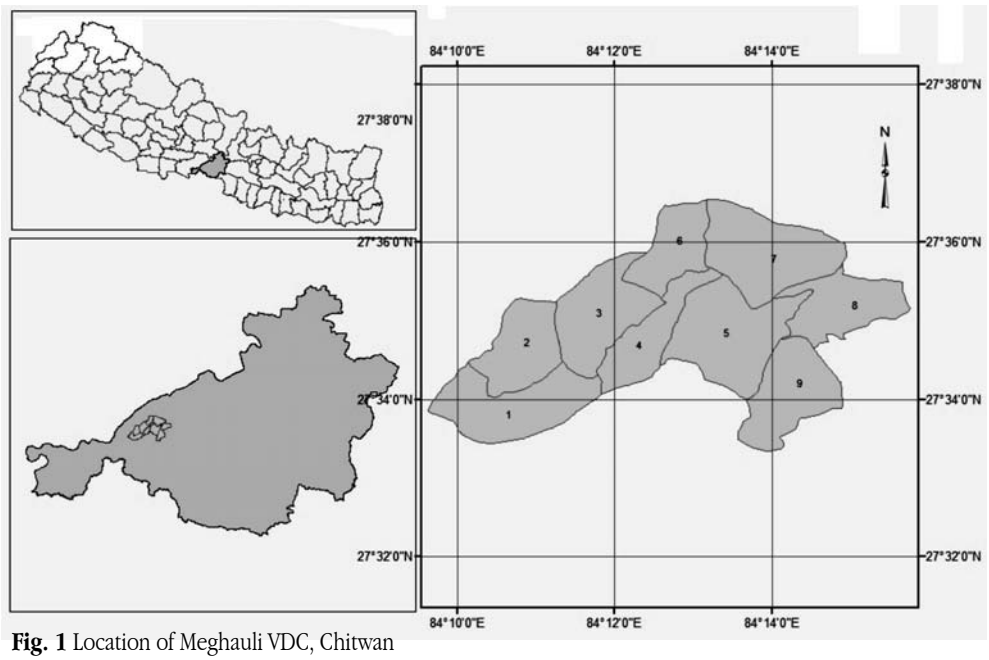

Fig. 1 Location of Meghauli VDC, Chitwan

toward climate change. The questionnaire forms were filled by the researcher interviewing with household heads or/and female respondents. The data obtained from the household survey were analyzed by using Microsoft Excel 2010. The reduction in CO_2 emission has been calculated by using the conversion factor for 1 kg of dry firewood emit 1.83 kg of CO_2 (IPCC, 1996).

Results and Discussion

Socio-economic condition

The most (98.84%) of the family in the study area were found to be Hindu, followed by a few Buddhist (1.16%). Among the ethnic groups, Brahmin, Chhetri, Mahato, Gurung, Tharu, Rai, Magar and Newar were the major ethnic groups. The average family size was found to be six, with single family type. Water and sanitation condition was observed to be satisfactory where almost all family were found to have toilet facility. The average household income was found to be about NRs. 11,500. Furthermore, almost every family has communication facilities like mobile/telephone, television, radio and others.

Energy use for cooking and lighting purpose

All the surveyed households in the study area were found to be using firewood for cooking and heating purposes. However, preference of people was found to be gradually changing from traditional sources of energy to cleaner sources of energy like Liquefied Petroleum Gas (LPG) (22.09%), kerosene (2.32%), biogas (1.16%), and electricity (10.46%) for domestic purposes. Similarly, nearly 94.18% of the surveyed households were found to use electricity, while 5.82% were found to be using kerosene for lighting purpose. At present, the preference for clean energy sources has been increasing which might be due to inconvenient availability of traditional fuel-wood, decreasing forest resources, as well as increasing income level. This means the energy consumption pattern is shifting from traditional to modern sources. In addition, awareness about environment friendly techniques leads people to use more efficient and modified traditional system such as ICS, biogas, bio-briquette, etc. which help in reducing firewood, saving time, effort and money. The Tinjure-Milke-Jaljale, high hill of eastern rural part of Nepal, shows that intervention of ICS appreciably reduced firewood consumption from a household to 4.5 million ton per year from 8.14 million ton per year which is 45% diminution of fuel wood. Consequently, reduced volume of firewood has been supporting in reducing the CO_2 emission. There is reduction of CO_2 emission from 14.9 million ton per household per year to 8.42 million ton per household per year. It has also been revealed that after using ICS technology, each household is contributing about 1.52 million ton carbon to sink in the community or natural forest in study area (Khanal & Bajracharya, 2010). Likewise, in the present study, there is significant reduction of firewood consumption and CO_2 reduction which support in leveling off the CO_2 concentration in atmosphere which is major component of climate change. Furthermore, intervention of ICS technology also helps to sink carbon in forest which helps to mitigate climate change.

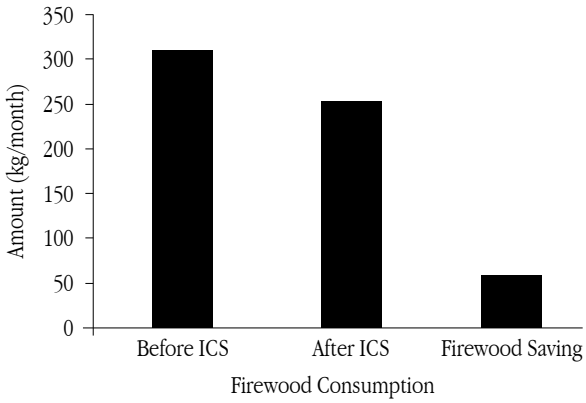

Fig. 2 Reduction in firewood consumption

Similarly, respondents agree that, ICS is one of the efficient, convenient, clean and time saving stove which help in reducing household drudgery for cleaning the kitchen, washing utensils, collecting firewood from distant area as well as it is good in appearance than the traditional stove. It is also one of the most likeable technologies because of use of firewood as means of fuel-wood can be obtained locally, needs low investment and is easy to install than the other alternative technologies. Despite various advantages of using ICS, it seems to be not preferred by few people. This might be due to some technical problem such as its modified structure and financial investment during installation and maintenance period which is somewhat difficult without prior knowledge and experience. Therefore, it requires adequate consideration while designing and developing the ICS and training for repair and maintenance.

Reduction in firewood consumption

It has been found that average firewood consumption by a family was 310.62 kg/month prior to the application of ICS, which was reduced to 253 kg/month after adopting it (Table 1). It shows that the ICS helped to save 57.62 kg/month firewood (Fig. 2**).** This means, about 3.727 million tons of firewood consumed by each household in a year was reduced to 3.036 million ton after ICS installation which is equivalent to 0.6914 million ton saving of firewood. Regarding the preference of people, nearly 73.68% showed their preference for ICS, 25% preferred traditional and 1.32% has no preference.

Table 1 Reduction of firewood and CO_2 emission from ICS adoption

Features	Firewood requirement (kg/month/HH)	CO_2 Emission (kg/month/HH)	Reduction in CO_2 emission (million ton/HH)	Reduction in CO_2 emission from 900 HH (million ton/yr)
Before ICS installation	310.62	568.43	1.265	1138.5
After ICS installation	253	462.99		

Reduction of CO_2 emission

Prior to the application of ICS, CO_2 emission from a household was calculated about 568.43 kg/month which however was found to decrease to 462.99 kg/month. Equally, this helped to reduce CO_2 by an average value of 105.44 kg/month. It gives a value of 1.265 million ton of reduction in CO_2 emission from an ICS installed household in a year. In totality, it helped to reduce 1143 million ton of CO_2 from 900 ICS installed houses in Meghauli VDC. Correspondingly, it shows about 18.55% of the CO_2 emission decreased from these houses (Table 1**)**.

Time saving for household work

From the present study, it has been found that in an average a woman spent 5 hours 15 minutes per day for household work as cooking for family, washing pots and cleaning the kitchen prior to using ICS, which was reduced to 4 hours 32 minutes per day for the same task after ICS installation. It means, about 43 minutes in a day was saved. In average, it helped to save 262 hours in a year which they could use in women empowering activities as well as taking care of them such as taking proper hygienic activities on daily basis.

Health status

About 11.63% people in the study area were found to be suffering from respiratory (40% asthma, 20% bronchitis, 20% throat infection and others) and eye diseases, 6.98% stomach pain, 5.81% headache and 11.63% others. In the present study, women were found to be greater in proportion suffering from respiratory diseases than the men which may be due to their prolonged exposure during cooking or indoor activities. Exposure to indoor air pollution, especially particulate matters, from the combustion of biofuels has been attributed as a causal agent of respiratory diseases in developing countries (Chen et al., 1990). Likewise, a well, non-smoking women who have cooked on biomass stoves for many years exhibit a higher prevalence of chronic lung disease (Parikh, 2007).

Perspectives of local people for climate change

In the present study, the majority (91%) of the respondents expressed that they were experiencing the climate change and its impact on their daily livelihood. They reported high temperature range (difference in hotness), change in precipitation pattern, more intense heat and cold waves respectively during summer and winter. The result shows that 80% respondents stated change in temperature and more than 90% respondents reported rainfall variability. The problems associated with rainfall variability are untimely and late monsoon, no or less winter rainfall as well as high intense rainfall for short time. Furthermore, about 40% respondents said that the incidents of drought has been increasing which has been attributed to untimely, unusual and less rainfall over past few years. Similarly, more than 80% respondents shared that they experienced increasing number of invasive pests and insects in compared to the previous years in their farmyard. The emergence of new pests and diseases made farmer to use high dose of pesticides. Likewise, 18.60% respondents reported loss of their crops and livestock due to flood and drought (Fig. 3**)**.

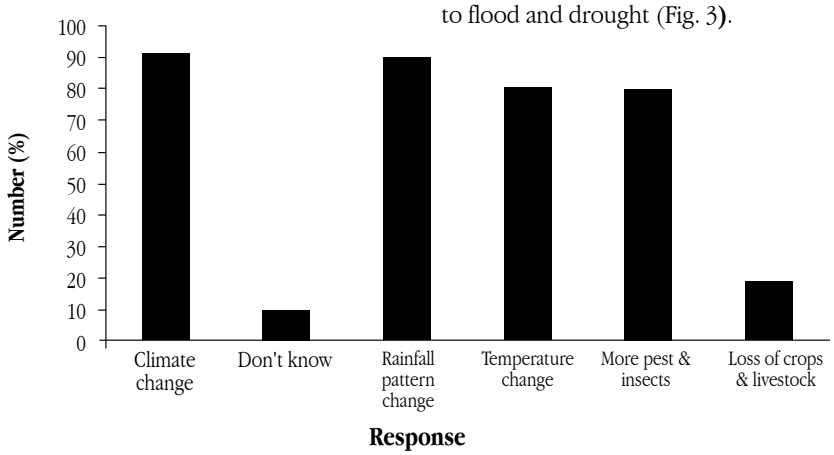

Fig. 3 Respondents response toward climate change

Conclusion

The installation of ICS, an eco-friendly technology, in Meghauli VDC has positively contributed to socio-economic and environmental situation. The use of ICS has resulted in the substantial reduction in firewood consumption and CO_2 emission in the household level. In addition, the reduced consumption of firewood reduced work burden with respect to time taken for collecting fuel from distant source and provided free time especially for women. Considerably, the study provides the benefits of using ICS, health status and the peoples' perspective toward climate change in the area.

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