**Knowledge and Perception of Population regarding the Contribution of Improved Cooking Stoves to Households’ Income and Environmental Protection**

Adelphine Mudashamagira

Development Sciences School

Institut Catholique de Kabgayi. Rwanda

admuda@yahoo.fr

ABSTRACT

This study examined the population’s knowledge and perception of the

Contribution of improved cooking stoves to household income and environmental protection in the muhanga district in rwanda. Using a survey questionnaire and an in-depth interview guide, simple random sampling and purposive sampling techniques were used for data gathering from 100 households in the muhanga district who use improved cooking stoves. The study found that residents recognized the contribution of improved cooking stoves to household income and environmental protection. Before using improved cooking stoves (ics), thirty-four percent, 34% of all respondents agreed with the decrease in forest cover , but after using ics, the number reduced to 3%. Before the use of ics, 27% of all respondents accepted that there was soil erosion, while after the use of ics, the number reduced to 7 results further suggest that after using ics, forests are increased; air pollution reduced and soil erosion is controlled. It was also revealed that monthly expenses were reduced from 30% to 8% for those who spent between 15000-20000 rwf. The overall finding of the study underlines the importance of strengthening the adoption of improved cook stoves. Results of this are important and will guide to policy makers, researchers, extension and farmers to build the case for the use of improved cook stoves as a form of intervention.

Key words: perception, improved cooking stove, household income, environmental protection.

**INTRODUCTION**

Human survival and prosperity are highly dependent on the environment. Complex ecosystems ensure a continuous supply of food and fresh water and provide wood and other natural resources for our use. These ecosystems regulate our climate and protect us from floods and other natural disasters. They have shown a remarkable capacity to accommodate more and more of our needs, yet, these very foundations of our existence are now endangered by population growth and the unsustainable use of natural resources (Barrow, 2005).

More than 2.4 billion people burn biomass fuels on a daily basis, mainly for cooking food. As a result, 2 million tons of biomass is going up in smoke every day. This may not pose a problem where the growth of new trees surpasses human demand. However, with increasing of demand of wood over time, wood collection can put considerable pressure on forests. Spending money on large quantities of inefficient fuels, where fuel is purchase, places severe constraints on household budgets. Poor households tend to spend a larger percentage of their income on energy than well-off households. Women and children spend many hours a week searching for fuel wood. Fuel collection is not necessarily a daily task, as the duration and frequency of collection varies depending on the availability of wood for use as a fuel source (Gill, 1985; FAO, 2003; UNDP, 2005b; Barnes et al., 2012 and Ekouevi and Tuntivate, 2012).

According to UNDP (2005b) and World Health Organization (WHO, 2006), energy is essential to meet our basic needs mainly for cooking, boiling water, lighting and heating. Worldwide, more than three billion people are dependent on burning wood, dung, and other traditional fuels inside their homes which results indoor air pollution. Due to this, more than 1.5 million deaths occur, mostly of young children and their mothers. Millions more are suffering every day with difficulties in breathing, stinging eyes, and chronic respiratory diseases (WHO, 2006). As a solution, many governments decide to implement and promote the use of improved cooking stoves (ICS) to address these adverse health and livelihood effects Since ICSs improves cooking efficiency compared to traditional cookstoves, ICSs can reduce the amount of fuel required, fuel gathering time, and cooking time, all of which have the potential to improve health and increase household income. In addition, these efficiencies can benefit the local environment and global climate because of the reduction in fuelwood harvesting and particulate emissions

This paper assesses the knowledge of the population regarding the contribution of using improved cooking stoves to households income and environmental protection in order to provide a useful insight into whether and how external assistance can be used more effectively to enable all households to secure their basic needs, promote self-reliance, and adopt sustainable appropriate technologies as a means of breaking the cycle of natural resource degradation to ensure environmental sustainability and eradicate disease, poverty, and hunger in these households.

The findings from the study may also be used by researchers, planners, and policy makers to build the case for more focused planning for interventions on technology within the development sector and will also contribute to knowledge in the area of environment and natural resource management.

**Materials and Methods**

The study was carried out in the Muhanga Districtne of the eight districts comprising the Southern Province of Rwanda, the Muhanga District and is among those where the program of improved cooking stoves has been implemented. The District covers an area of647.7 km2. It is neighboring the Districts of Gakenke in the north, Kamonyi in the east, Ruhango in the south, and Ngororero in the west (Muhanga DDP, 2013). The district’s natural plants or ecosystems have disappeared, leaving room for crops and artificial forests. The total households of Muhanga district is 71,661 households. The active population of Muhanga District is 86.4% compared to 13.4% of inactive population, with 0.3% unemployed. The majority of the populations of Muhanga District (78.5%) are in agriculture coupled with farmer’s livestock.

A significant proportion of the population (98,3%) of District HHs are using biomass as energy for cooking such as firewood (95.8%), charcoal (2.5%), at national level these are 86.3% for firewood and 10.6% for charcoal. The high use of firewood and charcoal contributes to deteriorating tree and vegetation cover exposing the soil to severe degradation especially on hill tops, a trend that threatens future livelihood activities. The population under the study is the households of Muhanga District using improved stoves. The researcher acquired data from the heads of households. The total households using improved stoves are 68,610 households (Muhanga Annual Report, 2014).

Simple random sampling and purposive sampling techniques were used. According to Amin (2005), purposive sampling is preferred in selecting people holding positions that allow them to be more knowledgeable with issues going in their area. It is in this respect that the researcher used purposive sampling for selecting key informants like person in charge of environment, Vice Mayor in charge of social affairs, agronomist and local leaders in Muhanga District as well as households using improved cooking stoves.

According to Amin (2005), simple random sampling is used in a situation when each respondent has an equal chance of being selected to participate in the study. This method was used because it helps in preventing bias sampling since every person has an equal chance of being selected. The selection of heads of households using improved stoves in the Muhanga District and local leaders was taken into account as they requested to take part in the study. The request involved self-introduction and soliciting respondents’ cooperation by explaining the objective of the study. Any respondent who accepted was selected to fill in the questionnaire.

Williamson (1982, p .113) comments on the sample size as being a phase of research, which is crucial because of its major impact on time and money that must go into data collection.

The sample size of the population of this research was calculated sector by sector for 12 total sectors of the Muhanga district.he total households using improved stoves are 68,610 households (Muhanga report, 2015) according tothe

following formula of Yamane (1967).

Where, n: is the total sample size

e: is stands for standard error

N: is the population

If we replace the letters by their respective values, we have: 99.85≈ 100 households

Thus, 100 households is our representative sample size of the total households of the Muhanga District using improved cooking stoves.

Table 1: Total households and its representative sample in each sector

**<Insert Table One Here>**

In this study, the researcher used different techniques and methods to collect data. Questionnaires were administered to the heads of households in the Muhanga District that use improved cooking stoves. Questionnaires were considered ideal because of the ease of administration and scoring of the instrument besides the results being readily analyzed (Ary, Jacobs & Razarieh, 1979; FAO, 1995a). The items on the questionnaire were developed on the basis of the objectives of the study. The questionnaire captured data on the socio-demographic characteristics of the respondents, and the degree of knowledge and perception of the population under the study to the contribution of ICSs to households’ income and environmental protection.

In addition, the interview was addressed to those in charge of environmental protection at district levels (i.e. District Environmental Officer), agronomist, the vice mayor in charge of social affairs, and local leaders regarding their opinion on the determinants of the importance of ICSs in Muhanga district.

All the data collected from the questionnaires and in depth interviews were analyzed in an ongoing process. Quantitative data was processed, coded and analyzed using MS excel. The results were presented by use of descriptive statistics, namely percentages and frequencies. For qualitative data, the researcher used a thematic approach. Thematic analysis is a search of themes that emerge as being important to the description of the phenomenon.

**Results and Discussion**

This section of the paper presents the key findings of the study. It is organized under three broad themes including: demographic characteristics of respondents, attitudes and perceptions regarding ICSs and environmental protection as well as ICSs and households’ income.

***Socio-demographic background of respondents***

In this section, respondents are presented by gender/sex, age, marital status, school level, and how long they have used improved cooking stoves.

***Characteristics of respondents according to their gender***

Table two identifies the gender of respondents. The results show that most of respondents are female (64%). Gender is important to determine characteristic of respondent who used improved cooking stoves. It is also important to help understand respondent’s perception of environmental and income issues. The results show that the females are more prevalent than males because generally cooking activities are considered to be their responsibility

Table 2. Gender of respondents

|  |  |  |
| --- | --- | --- |
| Sex | Number of respondents | Percentage |
| Female | 64 | 64 |
| Male | 36 | 36 |
| Total | 100 | 100 |

In terms of age, the table 3 indicate that the majority of the respondents (31%) were between 28 and 38 years old and only 11% is aged above 58. This indicates that youths are more numerous in our community and are responsible for their household.

**Table 3. Age of respondents**

Ages Number of respondents Percentage

Between 18- 28 13 13

Between 28- 38 31 31

Between 38-48 25 25

Between 48-58 20 20

Above 58 11 11

Total 100 100

*Characteristics of respondents by their marital status*

Table 4 presents the sample’s characteristics of respondents according to their marital status. The results revealed that 8% of all respondents are single, 71% of them are married, 4% of them are divorced, and 17% are widowed.

**Table 4. Distribution of respondents according to their marital status**

|  |  |  |
| --- | --- | --- |
| Marital status | Number of respondents | Percentage (%) |
| Single | 8 | 8 |
| Married | 71 | 71 |
| Divorced | 4 | 4 |
| Widowers | 17 | 17 |
| **Total** | **100** | **100** |

***Characteristics of respondents according to their level of education***

The findings represented in this table indicate the characteristics of respondents according to attained level of education. According to the findings, 5% of all respondents did not attend school; 45% of them attended at least primary level, 28 % of them attended vocational training centers, 18% of them attended secondary school, and only 4% of them reach the university level. This information helps the researcher to know if those people have the knowledge on the use of improved cooking stoves and their contribution on environmental protection. According to the results, most of respondent are primary educated, making up 45% of the sample.

**Table 5. Attained education level of respondents**

|  |  |  |
| --- | --- | --- |
| **Education level** | ***Number of respondents*** | **Percentage (%)** |
| Never attended school | 5 | 5 |
| Primary | 45 | 45 |
| Vocational training Center | 28 | 28 |
| Secondary | 18 | 18 |
| University | 4 | 4 |
| **Total** | **100** | **100** |

***Characteristics of respondents according to their profession***

The data reviews that 65% of all respondents are farmers, 21% of them are equipped with trading activities, 11% of them are public employees, 14 % of them have their own businesses, and 3% of them are unemployed. The fact that most of the respondents are farmers is noteworthy, it has potential to hinder use of technology negatively impacting effective implementation of improved cooking stoves.

**Table 6. Distribution of respondents according to their main occupation**

|  |  |  |
| --- | --- | --- |
| Profession | Frequency | Percentage |
| Farmer | 65 | 65 |
| Trader | 21 | 21 |
| Public employees | 11 | 11 |
| Freely employees | 14 | 14 |
| Jobless | 3 | 3 |

***The period during which respondent have been using improved cooking stoves***

The results incorporated in the table above presents the period respondent have used improved cooking stoves. According to the findings, 7 % of respondents have used ICS between 1 and 2 years, 14% of them have been using ICS between 2 and 4 years, 33% have been using ICS between 4-6 years, 28% are using it from 6 to 8 years, 13% are using ICS between 8-10 years, and 5% of them have been using ICS for 10 years or more. This indicates that after the government of Rwanda enacted a law protecting, promoting, and managing the environment by the government of Rwanda in past 10 years the number of those who use ICS is increasing.

**Table 7. The period during which respondent have used improved cooking stoves**

Period Number of respondents Percentage

Between 1-2 years 7 7

Between 2-4 years 14 14

Between 4-6 years 33 33

Between 6-8 years 28 28

Between 8-10 13 13

10 years and above 5 5

Total 100 100

***Knowledge and perception on the contribution of improved cooking stoves to household income and environmental protection***

The researcher found that 73% of the respondents use the Ceramic Jiko Stove , 1% use the Darfur stove, 27% use the Rocket stove, 6% use gas, and 2% use electricity. This information indicated the preference of people to different types of improved cooking stoves due to different factors. Those results are in agreement with the results from MININFRA(2010), which talked about the types of improved cooking stoves and their differences. According to this research, three main improved stove types are available, including the 3-stone stove, the Rocket stove, and the Darfur type. In the case of the Darfur type, assessments found wood fuel consumption savings of 28.43% and time saving of 21.49%.he Jiko has an efficiency rating of 28.97%. Social and environmental returns on investment are equally powerful.

In addition, an active private sector has also contributed to the uptake of a wide variety of stove types, which range in price, lifetime, and efficiency across charcoal and wood burning, portable and non-portable stoves. Major improved stove types include the Darfur stove, Rocket stove, and the combination metal/ceramic stove locally known as the canamaké, which originated as the Kenya Ceramic Jiko stove (MININFRA, 2010).

**Table 8. Types of improved cooking stoves used by respondent**

|  |  |  |  |
| --- | --- | --- | --- |
| The types ICS | | Number of respondents | Percentage |
| Fixed stove | Ceramic Jiko stove | 73 | 73 |
| Movable stoves | Darfur stove | 1 | 1 |
| Rocket stove | 27 | 27 |
| Gas and LPG | 6 | 6 |
| Electricity | 2 | 2 |

Also, according to a study done by MacCarty et al. in 2008, the findings indicate that the *improved rocket stove* is disseminated in many African countries by GIZ through their Program for Basic Energy and Conservation (ProBEC). While a conventional three-stone fire uses 6,553 kJ to boil 1 litre of water and then simmer it for 30 minutes, a rocket stove uses only 2,470 kJ/l to fulfil the same tasks and cuts cooking time from about 20 minutes down to 15 minutes.

**Table 9. Different types of fuels used by respondent in cooking**

|  |  |  |
| --- | --- | --- |
| Type of fuel | Number of respondents | Percentage |
| Fire woods | 84 | 84 |
| Charcoal | 22 | 22 |
| Gas | 2 | 2 |
| Electricity | 1 | 1 |

The findings presented in the previous table identify different types of fuels used by respondent in cooking. According to the findings, most respondents are using fire woods comprising 84% while, 22 % use charcoal in cooking, 2% use gas, and 1% of use electricity.

Data suggests that (Adkins et al., 2010) both energy consumption for cooking in developing countries and the potential energy savings from improved biomass cooking stoves are very high. Survey data from this study in Uganda suggests that the average quantity of food cooked per household is 3.19 kg per meal. The amount of wood used to cook this amount on a three-stone fire amounts to 1.77 kg, and an average household prepares 11 meals each week. If we accept these rough assumptions, each household in rural Uganda consumes about 20.25 GJ per year using a three-stone fire for cooking. An improved cooking stove, such as the Save 80, could reduce fuel wood input by up to 80 %, which is equal to cutting the wood fuel input from 1.77 to 0.35 kg per meal.

Hence, the use of an improved biomass stove could cut cooking related primary energy consumption of a single household by up to 16.25 GJ/year to a level of 4.00 GJ per year. The use of an improved rocket stove design instead of the Save 80 may significantly reduce costs of the measure to improve energy efficiency and still allow savings of about 12.15 GJ/year per household (around 60 % of the original fuel consumption). These enormous energy savings are a strong argument for the implementation of policy programs, which foster the dissemination of improved biomass stoves in rural areas in developing countries.

Table 10 presents wood fuel saved per meal per household (in kilograms). In accordance to the results, about 24 % of all respondents confirmed that their saved 1kg, while 26% of them saved 2kg, 29% saved fuel wood

3kg, 12% of them saved 4kg and finally 9% saved 5kg. A study conducted in Burkina Faso by the World Health Organization in 2006 confirmed that, using an ICS, households save on average 3.5 kg of firewood, or 1.9 kg of charcoal weekly.

**Table 10. Wood fuel effectively saved per meal per household**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Wood fuel used before using  ICS(in kg) | Wood fuel used after using  ICS(in kg) | Wood fuel  saved  (in kg) | Number of  respondents | Percentage |
| 3 | 2 | 1 | 24 | 24 |
| 4 | 2 | 2 | 26 | 26 |
| 6 | 3 | 3 | 29 | 29 |
| 7 | 3 | 4 | 12 | 12 |
| 8 | 3 | 5 | 9 | 9 |
| Total |  |  | 100 | 100 |

This table above summarizes the annual firewood saving in kilograms (kg). According to the results, most respondents saved firewood 1008 kg presented by 29 %; flowed by 26% of respondents who saved wood fuel equal to 672 kg, 24% saved 366 kg 12% saved 1344 kg, and 9% of respondents saved 1680 kg. Nahayo and Murindahabi (2012) confirmed that the improved firewood stove model contributes to the protection of forests significantly at the rate of 50.33%. This can save firewood consumption at a considerable proportion, reduce the cooking time for about 21%, and contribute to increase household income at 50.33% by reducing the budget required for the use of firewood.

**Table 11. The annual firewood saved**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Wood fuel used before  using ICS(in kg) | Wood fuel used after  using ICS(in kg) | Wood fuel  saved (in kg) | *Number of*  *respondents* | **Percentage** |
| 1008 | 672 | 366 | 24 | 24 |
| 1344 | 672 | 672 | 26 | 26 |
| 2016 | 1008 | 1008 | 29 | 29 |
| 2352 | 1008 | 1344 | 12 | 12 |
| 2688 | 1008 | 1680 | 9 | 9 |
| Total |  |  | 100 | **100** |

According to the results, the most respondent save the time between 45 minutes and one hour as represented 41%, followed by 29% of those who saved between 30 minute and 45 minute, followed by 25% of respondents who saved 1 hour and above, and 5%saved under 30 minutes . This is in line with what the WHO 2006 review found on fuel-collection time and biomass energy use among 14 countries in Sub-Saharan Africa. According to these results, there is a wide range of estimates for the number of hours spent collecting biomass energy, from a low of 0.33 hours up to 4 hours per day (Dutta, 2005; WHO, 2006). Niger, Burkina Faso, and Ethiopia countries with the highest levels of biomass scarcity had the higher levels of biomass collection time. A partial explanation for this finding might be the various ways in which the survey questions were asked; nonetheless, the results generally support the notion that worldwide collection of biomass energy requires a significant amount of time for rural households.

**Table 12. Times that respondent saves by using the improved cooking stoves**

|  |  |  |
| --- | --- | --- |
| Times | Number of respondents | Percentage |
| Under 30 minute | 5 | 5 |
| Between 30 minute and 45 minute | 29 | 29 |
| Between 45 minute and 1 hour | 41 | 41 |
| 1 hour and above | 25 | 25 |
| Total | 100 | 100 |

As shown in table 12, the most respondent save the time between 45 minutes and one hour as represented 41%, followed by 29% of those who saved between 30 minute and 45 minute, followed by 25% of respondents who saved 1 hour and above, and 5%saved under 30 minutes . This is in line with what the WHO 2006 review found on fuel-collection time and biomass energy use among 14 countries in Sub-Saharan Africa. According to these results, there is a wide range of estimates for the number of hours spent collecting biomass energy, from a low of 0.33 hours up to 4 hours per day (Dutta, 2005; WHO, 2006). Niger, Burkina Faso, and Ethiopia countries with the highest levels of biomass scarcity had the higher levels of biomass collection time. A partial explanation for this finding might be the various ways in which the survey questions were asked; nonetheless, the results generally support the notion that worldwide collection of biomass energy requires a significant amount of time for rural households.

**Table 13. How is the freed up time used**

|  |  |  |
| --- | --- | --- |
| the freed up time used | Number of respondent | Percentage |
| Enough time to study for students | 19 | 19 |
| Farming activities | 39 | 39 |
| Trading activities | 27 | 27 |
| Handcrafting activities | 42 | 42 |

The table above shows the freed up time used by respondents. According to the results, respondents said that they used the time saved from using improved cooking stoves for doing others interesting activities that generated money and improved their livelihoods. There were 19% who reported an increase in time for studying, 39% for farming activities, 27% for trading activities, and 42% for handcrafting activities. The time saved, in turn, can be freed to earn cash or produce other goods and services (Eckholm, 1983). Or even greater importance is ensuring that greater access to energy enables to use the time saved, particularly on collection of fuelwood, to participate more fully in other aspects of the economy, and in the process earn higher incomes (MININFRA, 2012).

***Knowledge and perception about the status of environment before and after the implementation of improved cooking stoves***

Figure 1. The environment status before and after the implementation of improved cooking stoves

<Insert Figure One>

Figure 1 indicates the state of environment before and after the implementation of improved cooking stoves. According to the table, 34% of all respondents agree with the decrease in forest cover before using improved stoves, but after the using improved stoves, the number reduced to 3%. Before the use of improved stoves, 27% of all respondents accept soil erosion, and after the use of improved stoves the number reduced to 7%. Before, 25% of respondents respond increase in indoor air pollution, but after using improved stoves, the number reduce to 1%. Before, indoor air pollution decrease in 1%, after using improved stoves, the number arose to 41% and finally only 2% of respondents agree with the decrease in soil erosion but after using improved stoves, the number arose to 31% of respondents. Reduced firewood consumption also positively impacts the environment as less wood resources will be harvested thereby reducing pressure on these natural resources. This was actually the push behind stoves programs in the 1970s. The agenda of improved stoves programs of the 1970s and early 1980s was the concern about the environment to combat deforestation and desertification (Barnes et al., 1994; Barnes et al., 1993; Nyström, 1994; Report3, 1993; Karekezi & Turyareeba, 1995).

The world today is confronted with enormous, interrelated challenges with regard to climate change, energy, economic sustainability, and poverty. About 2.5 billion people in the world rely on the traditional use of biomass, mostly firewood, for cooking. In many areas this implies pressure is put on the forest resources. Using wood energy for cooking may also bring a health risk, due to exposure to smoke. Every year, 3.5 million people die prematurely as a result of respiratory diseases caused by smoke inhalation related to these cooking methods. Although improved cooking stoves (ICS) have been promoted for decades, the renewed international attention stresses the importance of these stoves as a low-cost solution to improve indoor air quality, help reduce greenhouse gases, relieve the daily workload of women, and reduce expenditure on energy in poor households (IOB, 2013).

***The changes in health-related outcomes (symptoms of respiratory disease, eye infections)***

Table 14. The changes in health-related outcomes

|  |  |  |
| --- | --- | --- |
| Changes | Number of respondent | Percentage (%) |
| Reduction in respiratory disease | 46 | 46 |
| Reduction in eye infections | 39 | 39 |
| Reduction in headache | 34 | 34 |

The findings shows that 46% of respondents confirm reduction in respiratory disease, 39 % reported a reduction in eye infections and finally 34 % of respondents confirm a reduction in headaches. Measurements showed that compared to developed countries, in most households in the developing world, the standards of air pollution are exceeded by a factor of 2 to 60 (Gordon et al. 2004; Bruce et al. 2002). Improved stoves can avoid or at least reduce the amount of smoke generated during combustion through more efficient combustion processes or chimneys leading the smoke outside, for example.

***Comparing the household income generation before and after implementation of improved cooking stoves***

Figure 2. Comparison between the household income generation before and after implementation of improved fire woods stoves

<Insert Figure Two here>

The findings in figure 2 compare the monthly expenses before and after the implementation of improved cooking stoves. The results show that 30% of all respondents spent between 15000 – 20000 Rfw before using improved cooking stoves, but after using improved cooking stoves, the number of those who spent that amount reduced to 8% Before the use of improved stoves, 25% of all respondents spent ≤ 20000 Rfw, and after the use of improved stoves the number reduced to 4% of those who spent the same amount. Before, 17 % of respondents spent between 10000 – 15000 Rfw, but after using improved stoves, the number arose to 21% of those who spent the same amount. Before, 13% of respondents spent between 5000 – 10000 Rfw, after using improved stoves, the number arose to 39% and finally only 2% of respondents spent, ≥ 5000 Rfw but after using improved stoves, the number arose to 24% of respondents. Those results are supported by Barnes et al. (1994), UNDP (2005b), Manyo- Plange (2011) and Inayat (2011), where they discussed economic generated from the use of improved cooking stoves, for them, there are several components to economic factors which include household income, cost of equipment and fuel, and noneconomic costs such as time and access to fuels saving from adoption of using improved stoves.

Table 15. How respondent are using the savings from the use of improved cooking stoves

|  |  |  |
| --- | --- | --- |
| Alternatives | Number of respondent | Percentage |
| able to save in financial institutions | 51 | 51 |
| able to pay for their children school fees | 33 | 33 |
| they paid themselves health insurances | 31 | 31 |
| Construction of the houses | 45 | 45 |

When discussing with respondents how the savings gained from using improved cooking stoves, they said that they used it to develop themselves in daily activities and that after using improved cooking stoves they were able to save in financial institutions by 51%. Thirty-three percent reported being able to pay for their children school fees; 31% paid health insurance themselves, and 45% focused on the construction of their own homes. This shows the improvement of livelihoods due to the use of improved cooking stoves.

The interviewers included the Environment Officer, Agronomist, V/M in charge of social affairs and local leaders and inquired as to their perception pf the contributions of improved cooking stoves to household income, livelihoods conditions, and environmental protection in the Muhanga District focusing on the following topics:

Saving in financial institutions

Construction of houses

Reduction in respiratory disease

Soil erosion reduction

Landslide reduction

Increase in forest cover

Reduction in deforestation

Reduction in indoor air pollution

This study was set to investigate the knowledge and perception of the Muhanga District residents on the contribution of ICSs to environmental protection and households’ income. The study was necessary because the more than half of the county’s population relies on solid fuel, such as biomass for their cooking needs.

Unprocessed biomass (e.g. charcoal, wood, crop waste) remains a major household fuel source for most residents of low income countries particularly the poor. During cooking, inadequate ventilation and incomplete combustion through the use of rudimentary stoves or open fire pits are common resulting in acute and chronic exposure to air pollutants (particulate matter, carbon monoxide, nitrous oxides, carcinogens and others). Exposure to household air pollution has been linked to a range of negative health outcomes in children and adult, including pneumonia, tuberculosis, chronic obstructive pulmonary disease, and lung cancer low birth weight and premature mortality.

Faced with this situation, the Government of National Union found it necessary and urgent to provide the country with an environmental policy capable of improving man’s well-being, with a view to guaranteeing sustainable utilization of natural resources and the protection of vital ecosystems for present and future generations. Implementation of Improved cooking stoves as measure help to reduce the pressure placed on local forests by reducing the amount of firewood fuel consumed during cooking. Additionally, the money a family spends on wood is reduced considerably. This translates into money being available to be spent on food, education, and medical care.

The findings confirmed the population knows the importance of the using improved cooking stoves to household income but also ICS contributed to environmental protection like other governmental programs such as afforestation, terraces implementation, etc. as environmental protection measures so there is need for regular sensitization on the importance of using improved cooking stoves for management and conservation of environment.

**References**

Amin E. Martin. 2005. Social science Research: Conception, Methodology and Analysis,Makerere University, Kampala Uganda.

Adkins, E.; Tyler, E.; Wang, J.; Siriri, D.; Modi, V. (2010): Field testing and survey evaluation of household biomass cooking stoves in rural sub-Saharan Africa. Energy for Sustainable Development. Copenhagen, Denmark.

Akabah, E.M. (1990). Real incomes and the consumption of woodfuels in Ghana: an analysis of recent trends.

Energy Economics 12 (3). 227-231

Alam, Manzoor, Joy Dunkerley, and A. K. Reddy. (1985). "Fuelwood Use in the Cities of the Developing World: Two Case Studies from India." Natural Resources Forum 9(3): 205-13.

Alternative Energy Promotion Center (AEPC), (2014). Rural Energy Development Program (NEP/07/011). Nepal.

Barnes, D., Openshaw, K., Smith, K.R. & van der Plas, R. (1993). The design and diffusion of improved cooking stoves. The World Bank Research Observer, 8 (2).119-141.

Barnes D., Openshaw K., Smith K.R., and Vander Plass R. 1994. What makes people cook with improved Biomass stoves. A comparative international review of stove programs. The international bank for reconstruction and development/the World Bank. Washington D.C USA.

Barnes D., Floor, W. (1996). Rural energy in developing countries: a challenge for economic development, Annual

Review of Energy and the Environment 21. 497-530

Barnes D., Singh B, and Xiaoyu Shi. 2010. Modernizing Energy Services for the Poor: A World Bank Investment

Review—Fiscal 2000–08. Washington, DC: World Bank

Barnes D., Kumar P, Openshaw K (2012). Cleaner hearths, better homes: New stoves for India and the developing world. The International Bank for Reconstruction and Development; Oxford University Press, New Delhi.

Barrow CJ (2005). Environmental management and development. Taylor & Francis Group, London.

Bhattacharya, S. & Cropper, M. L. (2002). “Options for Energy Efficiency in India and Barriers to Their

Adoption”. A Scoping Study. Washington, DC, US.

Bensch G., M. Grimm, K. Peter, J. Peters and L. Tasciotti (2013), Impact Evaluation of Improved Stove Use in Burkina Faso – FAFASO. Institute of Social Studies, Erasmus University Rotterdam; Rheinisch- Westfälisches Institut für Wirtschaftsforschung

Berrueta V.M., Edwards R.D. & Masera O.R. (2008). Energy performance of wood-burning cookstoves. Michoacan, Mexico.

Biran A.L. Smith, Jo Lines, Jeroen E., and Mary C. (2007). “Smoke and malaria: are interventions to reduce

Bruce, N., Perez-Padilla, R. and Albalak, R. (2002). The Health Effects of Indoor Air Pollution Exposure in Developing Countries. WHO/SDE/OEH/02.05. World Health Organization.

Campbell B.M., Vermeulen S. J., Mangono J.J., Mabugu R. (2003). The energy transition in action: urban domestic fuel choices in changing Zimbabwe, Energy Policy

Davis, L. W. 2008. “Durable goods and residential demand for energy and water: evidence from a field trial.” The RAND Journal of Economics 39 (2): 530–546.

Douglas F. Barnes, Keith Openshaw, Kirk R. Smith, and Robert van der Plas (1994). What Makes People Cook with Improved Biomass Stoves. Washington DC

Duflo E, Greenstone M (2008). Indoor Air Pollution, Health and Economic Well-being Surveys and Perspectives Integrating Environment and Society (SAPIENS). Vol. no.1,

Dutta, S. 2005. “Energy as a Key Variable in Eradicating Extreme Poverty and Hunger: A Gender Perspective on Empirical Evidence on MDG #1.” DFID Discussion Paper. London: UK Department for International Development.

Eckholm, Eric. 1975. The Other Energy Crisis: Firewood. Worldwatch Paper No. 1. Washington, DC: Worldwatch Institute.

Eckholm. (1983). "Unicef and the Household Fuels Crisis." Children's Fund. New York: United Nations

Ekouevi K, & Tuntivate V (2012). Household energy access for cooking and heating: Lessons learned and the way forward. Washington, D.C.: World Bank.

ESMAP/Univ. Pennsylvania. 1991. "Energy Use in Three Poor Counties in China: Interim Findings of

ESMAP/China Household Energy Survey." Energy Sector Management

Ezzati, M., & Kammen, D. M. (2000). The Health Impacts of Exposure to Indoor Air Pollution from Solid Fuels in

Developing Countries: Knowledge, Gaps, and Data Needs. Environmental Health Perspectives,

FAO (1983a). Wood fuel surveys. Retrieved November 6, 2015 from http://www.fao.org/docrep/Q1085e/q1085e0b.htm#TopOfPage

Gill, J. (1985). Stoves and Deforestation in Developing Countries. Paper presented at the UK-ISES Conference, "Energy for Development- what are the solutions?" United Kingdom.

Gill, J. (1987). Improved stoves in developing countries: a critique. Energy policy, 15 (2), pp.135-143.

German Agency for Technical Cooperation (GTZ). 2009. “Carbon Markets for Improved Cooking Stoves: A GTZ

Guide for Project Operators.”

Gordon, Bruce, Richard Mackay, and E Rehfuess. (2004). Inheriting the world: The atlas of children’s health and

the environment. Geneva.

Grupp, M. (2004). Domestic cooking appliances in developing countries - Economic and environmental aspects. Proceedings of the Domestic Use of Energy Conference 2004. Cape Town, South Africa.

Habermehl H. (1999). GTZ. Economic evaluation of the improved household cooking stove dissemination program. Kampala Uganda.

Heltberg R., Arndt T., Sekhar N. (2000). Fuelwood consumption and Forest Degradation: A Household Model for Domestic Energy Substitution in Rural India, Land Economics

Hosier R.H., Dowd, J. (1987) Household fuel choice in Zimbabwe: an empirical test of the energy ladder hypothesis, Resources and Energy

Hosier R.H., Kipyoda W. (1993). Urban household energy use in Tanzania: Prices, substitutes and poverty, Energy Policy

Hutton, G., and E. Rehfuess. 2006. “Guidelines for Conducting Cost-benefit Analysis of Household Energy and Health Interventions to Improve Health.” Paper prepared for World Health Organization, Geneva.

Hutton, G., E. Rehfuess, F. Tediosi, and S. Weiss. 2006. “Evaluation of the Costs and Benefits of Household Energy and Health Interventions at Global and Regional Levels.” Paper prepared for World Health Organization, Geneva.

IEA (International Energy Agency). 2009. World Energy Outlook 2009. Paris: Organisation for Economic Co- operation and Development/International Energy Agency. Paris.

International Energy Agency (IEA) (2011). Energy for All - Financing access for the poor, IEA: Paris, France

IOB (2013), Renewable Energy: Access and Impact. A systematic literature review of the impact on livelihoods of interventions providing access to renewable energy in developing countries. The Hague: Ministry of Foreign Affairs of the Netherlands.

Karekezi S. & Turyareeba P. (1995). Woodstove dissemination in Eastern Africa. Energy for Sustainable Development, 1 (6), pp.12-19.

Kothari , C.R (2004) , Research Methodology :Methods and Techniques .(2ndEd) ,New Age International Publisher Limited , New Delhi ,India .

Leach G. (1992). The energy transition, Energy policy 20 (2), pp. 116-123

Lewis J, Pattanayak S (2012). Who Adopts Improved Fuels and Cook stoves? A Systematic Review. Environmental Health Perspectives.

MacCarty N., Still D. and Ogle D. 2010. “Fuel Use and Emissions Performance of Fifty Cooking Stoves in the Laboratory and Related Benchmarks of Performance.” Energy for Sustainable Development.

Martins, J. (2005). The impact of the use of energy sources on the quality of life of poor communities, Social

Indicators Research 72 (3), pp. 373-402

Masera O.R. (1990). Sustainable Energy Scenarios for Rural Mexico: An Integrated. Evaluation Framework for

Cooking Stoves, M.Sc. Thesis, Energy and resource Group, U.C. Berkeley

Masera O.R., Saatkamp B.D., Kammen, D. M. (2000). From Linear Fuel Switching to Multiple Cooking Strategies: A Critique and Alternative to the Energy Ladder Model, World Development 28 (12), pp.2083-2103

MININFRA (2010). “Objectives of energy sector in the development of the country”. CARE Rwanda and

MININFRA Charcoal Value Chain workshop. Kigali, Rwanda.

MINIRENA, 2008. National Strategy and Action Plan for Biodiversity Conservation in Rwanda, Kigali, Rwanda. MINITERE, (2009). National Strategy and Action Plan For The Conservation of Biodiversity. Kigali, Rwanda

Muhanga, (2013).District Development Plan (2013-2018), Southern Province, Rwanda

Muhanga, (2007).District potentialities assessment for the integrated and self-cantered local economic development, southern province, Rwanda

Muhanga annual report (2014) The level of using improved cooking stoves in sectors of Muhanga district, Muhanga, Rwanda.

Mukamana, G. (2007). Data analysis instruments: Mount Kenya University press, Thika

Nahayo and Murindahabi (2012) Assessing the contribution of improved stove to the household income and environmental protection Bachelor dissertation. Higher Institute of Agriculture and Animal Husbandry (ISAE), Rwanda.

NJOGU, PAUL KURIA (2011) adoption of energy efficient woodstoves and contribution to resource conservation in nakuru county, Kenya Nairobi

Nyström M. (1994). FOCUS Kitchen Design: A study of housing in Hanoi. Lund, Sweden.

OECD (2005); Energy Price Subsidies. Total for developing countries and transition economies. Paris

Practical Action, (2009). What users can save with energy-efficient cooking stoves and ovens. Germany.

Ramanathan, Veerabhadran, and G. Carmichael. 2008. “Global and Regional Climate Changes Due to Black

Carbon.” Nature Geoscience 1: 221–27.

Report3 (1993). Kitchens, Living Environment and Household Energy in Vietnam. Lund, Sweden, BTJ Tryck AB. REMA, (2009). State of environment report and outlook: Kigali, Rwanda Rwanda Environment Management Authority (REMA), (2010). Guidelines to Mainstream Climate Change Adaptation and Mitigation in Energy and Infrastructure Sectors, Prepared by CRA Consultants. Kigali, Rwanda.

Sathaye J., Tyler S. (1991). Transitions in household energy use in urban China, India, The Philippines, Thailand, and Hong Kong. Annual Review of Energy 16, pp. 295-335.

Smith, Kirk R., S. Gu, K Huang, and D. Qiu. (1993). "One Hundred Million Improved Cook stoves in China: How Was It Done?" World Development.

Troncoso, K., Castillo, A., Masera, O., Merino, L. (2007). Social perceptions about a technological innovation for fuelwood cooking: Case study in rural Mexico, Energy Policy 35, pp. 2799-2910

UNDP (2005b). Energizing the Millennium Development Goals: A Guide to Energy’s Role in Reducing Poverty. United Nations Development Program (UNDP). New York, USA.

UNEP (2005). “Environmental Threats and Opportunities Assessment”. Kigali, Rwanda.

Venkataraman, C., A. D. Sagar, G. Habib, and K. Smith. (2010). “The National Initiative for Advanced Biomass

Cookstoves: The Benefits of Clean Combustion.” Energy for Sustainable Development 14(2):63–72.

Weiss CH. 1995. Nothing as Practical as Good Theory: Exploring Theory-based Evaluation for Comprehensive Community Initiatives for Children and Families. In New Approaches to Evaluating Community Initiatives. Washington, DC

White H. 2009. Theory-Based Impact Evaluation: Principles and Practice. 3ie Working Paper. New Dehli.

World Bank (1996). Rural Energy and Development: Improving Energy Supplies for Two Billion People.

Washington, DC: World Bank.

World Bank (2008). “Addressing Indoor Air Pollution in Africa.” Energy Sector Management Assistance Program

(ESMAP). Washington, DC: World Bank.

World Bank, (2009). Environmental Crisis or Sustainable Development Opportunity: Transforming the Charcoal Sector in Tanzania. Policy Note. Environmental and Natural Resources Unit, Africa Region, World Bank, Washington, DC.

WHO (2002). Global Update 2001: Particulate matter, ozone, nitrogen dioxide and sulfur dioxide. Air Quality

Guidelines. Copenhagen.

WHO (2006). “Fuel for Life: Household energy and Health”. France

WHO, (2007). Indoor Air Pollution: National Burden of Disease Estimates. World Health Organization. Geneva

World Health Report (2008). Country Profiles of Environmental Burden of Disease: India’, Public Health and the Environment, Geneva.

World Vision (2011). Fuel-efficient cooking stoves: A triple win for child health, development and Environment: Condensed report summaries from Ethiopia and elsewhere. Australia.

Wuppertal Institute (2011). Food Issues, Renewable energy for food preparation and processing. WISIONS brochure. Wuppertal

Yamane, T. (1967). Statistics: An introductory Analysis. New York: Harper

**Acknowledgements:**

The author would like to devotedly acknowledge the support from the Institut Catholique de Kabgayi (ICK)