Analysis of Biomass Use as Energy Sources among Rural Households in Khaukhwe, North West Province South Africa

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Doi:10.5901/mjss.2014.v5n27p948

Abstract

The main objective of the study was to analyse the use of biomass energy in Khaukhwe village of the Greater Taung municipality of the North-West Province. The study was conducted among 180 respondents. Data were collected using structured questionnaires which included open and closed ended questions. Questionnaires were coded, captured and analysis was done using statistical package for Social Sciences (SPPS). The findings show that 23.9% of the respondents were married and were mostly females (62.2%); 56.67% had 1-3 children with 11.67% having 4-6 children; 66.7% of the respondents have high school qualifications. The respondents have large families, 68.2% had between 4-6 members in the household. The findings revealed that 89.91% respondents walks 1-3 km to collect biomass fuel. The most predominant type of energy used is biomass at 99.4% and the respondents preferred biomass at 99.4% and 91.1% indicated that it is important to them. Of all types of biomass listed, wood was the most predominant type used (98.3%) and was also important to them (97.2%). The findings show that respondents were favourably disposed to the use of biomass through the following statements and indicated that biomass is cheap (77.8%), biomass collection is gender biased (68.3%), biomass collection is time consuming (53.9%) and biomass is easily accessible (46.7%). It was strongly agreed that biomass is cheap, hence, the high dependency rate. The study revealed that biomass was mainly used for cooking and space warming (100%), the constraints in biomass collection were impacted on the harvesters (100%), distance travelled for harvesting was 100%, labour involved in harvesting was 100%, harvesting biomass is time consuming (100%) and is done, frequently (100%), there were health hazards (100%) and reduces agricultural activities (99.4%). The analysis of the results shows that the autonomous level of use of biomass by rural dwellers is -10.26. The model has a good fit and it is significant at 1% ($\chi 2 = 84263.00$, $df = 162$, $p < 0.01$). Fourteen explanatory variables were significant while four variables were insignificant. The significant variables include attitude ($t = -4.112$, $p < 0.05$), constraints ($t = 3.815$, $p < 0.05$), age ($t = 4.944$, $p < 0.05$), race($t = 2.234$, $p < 0.05$), gender($t = 3.406$, $p < 0.05$), language($t = -13.544$, $p < 0.05$), educational level($t = -8.189$, $p < 0.05$), employment type($t = -10.115$, $p < 0.05$), dwelling type($t = 2.364$, $p < 0.05$), distance for biomass collection ($t = 5.142$, $p < 0.05$), cooking times per day ($t = -12.385$, $p < 0.05$), cooking duration per meal ($t = 14.882$, $p < 0.05$), cooking years ($t = -9.846$, $p < 0.05$) and homes with separate kitchen ($t = -7.908$, $p < 0.05$).

Keywords: *Biomass, energy, rural households, attitude, South Africa*

1. Introduction

Sustainable development is intricately linked to which environment can only be attained through sustainable energy systems in place (Dankelman, 1998). Energy is central to sustainable rural development and poverty reduction efforts as it affects all aspects of development, i.e., social, economic and environmental including livelihoods, access to water, agricultural productivity, health and population levels, education and gender-related issues. (Denton, 2002:9) noted that none of the Millennium Development goals can be met without major improvements in the quality and quantity of energy services in developing countries.

Biomass energy is usually defined as fuel wood, agricultural residues, and animal dung. In essence biomass energy is derived from recycling agricultural by-products, animal dung and crop residues to useful energy for the household. Biomass is material derived from living organisms such as trees, shrubs and cow dung. In contrast, biomass means plant and animal based material. There are different types of biomass energy, namely; crop residue which is the maize cob, rice husk, straw animal dung which consists of cow, and donkey dung and waste materials such as papers (World Bank, 1980). Biomass for household use is gathered from roadsides, natural woodlands, or communal woodlots. It can be grown on the homestead in private woodlots In Malaysia and Indonesia, non-industrial plantation of different types; for example, coconut, rubber, fruits orchards and trees in homestead and gardens have gained recognition as

important sources of wood fuel supply (Kituyi, 2001).

In Thailand, the energy balance shows that bagasse and rice husk accounted respectively for 7.9% and 1.6% of all energy used in the country in 1995. Once collected biomass may be transported to homestead on the heads of women and children, strapped to a mule or the back of a bicycle, piled in a wheelbarrow or on a scotch-cart (Kituyi, 2001). Household energy supply strategies vary from country to country and from village to village. Moreover when the primary household fuel is biomass, energy supply strategies are inseparable from land management strategies and are thus dependent on political and socio-economic issues like land tenure and tree tenure. In Indonesia, residues accounted for 7–8% in 1992, in Malaysia it was 15–16% in 1990 and data for the domestic sector are often not available. Evidence from limited surveys indicates that biomass in the form of residues plays an important role particular in areas where wood as a source of energy is in short supply (Cecelski, 2000).Fuel wood is a non-timber forest product (NTFP) that accounts for one of the main uses of forests and woodlands (Dovie, 2004). Access to secure energy supplies is widely acknowledged as a critical foundation for sustainable development (Shackleton, 2007). Within this understanding many countries including the post-apartheid government in South Africa, undertook massive electrification programmes (Howells, 2006).

In addition, energy is central to sustainable rural development and a poverty reduction effort as it affects social, economic and environmental development. Energy can play a crucial role in underpinning efforts to achieve the Millennium Development Goals, and improving the lives of poor people across the world. Hence lack of access to adequate, affordable, reliable, safe and environmentally benign energy is a severe constraint on development. Thus (Denton, 2001:9) believes that none of the Millennium Development Goals can be met without major improvements in the quality and quantity of energy services in developing countries.

According to Nadejda (in IEA, 2000:68) rural Africa is characterized by a heavy dependency on biomass energy. Essentially all of those users of traditional fuels reside in developing countries and most of them live in rural areas. The effect of firewood use in rural areas is that wood is extensively subsidizing the poor and the unemployed villagers. The free availability and accessibility of firewood leads to exploitation of the environment, at the same time rapid harvesting of trees and their slow recovery rate leads to women traveling long distance in search for fuel wood. Due to the aforementioned activities, fuel wood in rural areas is heavily gathered and consumed in unsustainable manner by households in the village there is likelihood that the community in Khaukhwe is doing the same practice.

Wood and charcoal for example, are significant source of jobs in rural areas where high unemployment often drives people to take jobs in towns and cities dividing families. Wood and other types of biomass are widely used as fuels in the domestic and industrial sectors, basically because they are cheaper than other fuels. Local availability and reliability of supply add to the economic advantages because it has been used by rural populations for innumerable centuries for their energy use like cooking, heating and lighting. According to (Kgathi, 1994) in Molepolole fire wood is socially used for open fire in weddings, funerals and other rituals. The firewood is used in funerals to prepare food and bath water whilst adult males use it at the assembly point (the kgotla). The use of wood and some other forms of biomass energy such as charcoal generates local employment than any other form of energy. In Ghana in a village called Obakrowa for example, large amount of unskilled labour is engaged in growing, harvesting, processing, transporting and trading the fuels which generates off-farm income for rural populations, either regularly or off-season (World Energy Outlook, 2000).The situation in this rural areas ensure sustainability because they do not only cut down the trees, they also grow them. The sustainable use of biomass energy sources helps to manage the local environment. Sustainable use of biomass is also beneficial for the global climate, because it is carbon-neutral whereas substitution by fossil fuels would add to the greenhouse effect (World Energy Outlook, 2000).

Rural households are highly dependent on forest resources for their livelihoods including energy needs. Biomass energy plays a key role in meeting the energy demands of the rural population including cooking needs of households. Fuel wood supply is a crucial issue as it affects environmental, health and social aspects. These are the issues that face the rural poor every day of their lives. To improve the environmental health and social aspects coupled with the use of fuel wood, government has embarked on an electrification programme. According to (Shackleton et.al 2007) South Africa produces and consumes over 60% of the electricity on the African continent and it is a twelfth highest carbon emitter in the world.

However, despite the substantial household electrification the use of fuelwood as a source of energy continues, reason being that most of these households cannot afford the appliances nor monthly costs of electricity. In addition intensive household use of fuel wood as a common property resource goes largely unregulated, and thus poses a high risk to both trees and the people who depend on them for their livelihood. Shackleton (in ProBEC, 2007) and (Bhattacharya, 1999) identified different traditional cooking technologies such as traditional clay stove, three stone traditional stoves and mud stoves existing in the rural sectors as “inefficient”. This is because air pollution from using fuel wood unsustainably is still a familiar sight in developing countries, where women and children are the most affected.

Researches has identified biomass smoke as a cause of acute upper and lower respiratory infections, chronic bronchitis, lung cancer, asthma, pulmonary tuberculosis, low birth weight babies and cataracts (Akhtar, 2007). There is therefore a need to establish how communities use fuel wood energy to minimize on wastage and exposure to poisonous gases.

The main aim of this study is to analyze the use of biomass as energy source in Khaukhwe village, North West Province South Africa. Specifically, the paper identified personal characteristics of rural dwellers; types of biomass use for energy; preference for biomass, determined attitude towards the use of biomass; and identified the constraints associated with the use of biomass energy. Significant relationship between socio-economic characteristics and the use of biomass were explored.

2. Methodology

The study was conducted in the Dr Ruth Segomotsi Mompati District in Khaukhwe village of Greater Taung Local Municipality in the North-West province. Taung is situated in the Harts valley on the right bank of the Harts river near its confluence with the Dry Harts river about 50 kilometres South-West of Vryburg and 180 kilometres North-East of Kimberley. Khaukhwe occupies the central district of Greater Taung municipality, about 42 kilometers on the Western part of Taung station. The village is mainly dominated by the Batswana speaking people. The community uses both communal owned land and non-communal forests for products such as fuel wood, building material (fence poles, house construction and planks), fruits and medicinal herbs. The village has a total of 191 households (Statistic South Africa, 2011). Although there is electricity supply lines to the village, residents have to travel to Taung (42km) or Vryburg (68km) to recharge their electricity cards.

The population for this study includes all household in Khaukwe village. There are 190 households with 530 people in Khaukhwe village (Statistics South Africa, 2011). From a list of 190 households, a sample was randomly selected using draw and pick from a jar. The importance of a sample size is that is the crucial role it plays in conducting statistical tests and analysis. A sample size used in making an appropriate decision about the results from which the sample has been drawn. This means that if the sample size is too small then a systematically conducted study can fail to detect the important effects, association or correlations. If the sample is too large the study would be complex and tedious. Thus, an optimal sample size is the most important part in any statistical study (Lani, 2009).

A structured questionnaire was designed based on the objectives of the study. The questionnaire, as a data collection tool, consists of close and open ended questions. The questionnaire was set in English and translated to the respondents who did not know the language. The questionnaire was designed to capture information about respondents on age, race, gender, marital status, number of dependents, language, level of education, types of employment, types of dwelling, household size, distance travelled for biomass collection including other demographic and socio-economic variables. Data collected were coded, entered into a spreadsheet and analyzed using (SPSS) Statistical Package for Social Sciences. Descriptive statistics such as mean, frequency distribution and standards deviation were employed to summarize the socio- economic data. The Probit Regression Model was used to analyze the biomass use as energy source among rural households. A binary dependent variable, while the independent variables are in the multiple continuous and categorical variables, makes probit a suitable choice for this empirical analysis (Ameniya 1981& Maddala, 1983). The choice of explanatory variables (socio-economic characteristics) was based on literature on past studies and the characteristics found among the respondents. The relationship between the probability of use variable Pi and its determinants q is given as:

$Pi = \beta qi + \mu i$, where $P_i=1$ for $X_i \geq Z$; i=1,2 .....,n;

qi is a vector of explanatory variables

β is the vector of parameters.

The probit model computes the maximum likelihood estimator of β given the non-linear probability distribution of the random error μi. The dependent variable Pi is a dichotomous variable which is 1 when a household uses biomass and 0 if otherwise. The explanatory variables are:

X_1 Attitude
X_2 Constraints
X_3 Age
X_4 Race
X_5 Gender
X_6 Marital status
X_7 No of Children
X_8 Language
X_9 Educational level
X_{10} Employment type
X_{11} Dwelling type
X_{12} Household size
X_{13} Distance for biomass collection
X_{14} Cooking times per day
X_{15} Cooking Duration per meal
X_{16} Cooking years
X_{17} Homes with separate kitchen

3. Results and Discussion

The demographics of respondents are presented in Table 1. The results indicate that 50% respondents were less than 30 years, this is a sign that biomass collection is done mostly by youth who are supposed to be busy in production. There were 21%respondents between 30 and 40 years and 17% were aged between 41 and 50 years. Only 11% were those above 50 years. The findings, regarding marital status, revealed that 24% of the women respondents were married, while 2.8% were divorced, 53% were single, 12% were cohabiting, 5% were widows and 3.3% were widowers. The highest percentage distribution of household sizes of respondents were57% for women, with 1-3 number of dependents. This was followed by 12% for women with 4-6 dependents. The increase in the size of households is associated with an increase in the amount of fuel wood consumption and depletion of resources. The least is 31% for women with no dependents. The reason could be that some are young girls who are still at school, or infants. The percentage of respondents showed that 66.7% respondents were Batswana followed by Xhosas with 12.8% and Afrikaners at 5.6%.The distribution percentage according to education level show that 94.4% attended up to primary level and high school and tertiary education was low (4.4% and 0.6%). The high rate on primary education in Khaukhwe is because there is only a primary school in the village; pupils have to travel very long distances to attend high school. The results show that most of the respondents are farm workers at 74% followed by artisan at 12%, government employees are 10% and 3.33% were private employees. The findings revealed that respondents living in RDP houses were 60.6%, followed by 24.4% living in self-built brick structures with 3.3% as the lowest living in mud houses.

The household size is important for this study as it indicates the number of people benefiting from the households consumption of energy and fuel wood collection support. The highest percentage distribution of household sizes are 68.2% for parents with number 4-6 children, followed by 29.5% for parents with 1-3 number of dependents, the least is 2.3% with people above 6 in the house. A major problem is the vast distance women in Khaukhwe have to travel in order to collect biomass for energy (Morgan, 1980:27). (O'Connor, 1991:1060) states that the work of collecting fuel wood for households often involves a long walk with a heavy loads was mainly done by women and female children. The findings reveal that the majority (89.91%) walk 3km to collect biomass for domestic energy needs, followed by 8.89 % of respondents walking above 3km per day and those who walk less than 1km. The reason for others to walk such a short distance is that they are too old to walk long distances and others live at the outskirts of the village where the forest is very dense.

All of the respondents (100%) indicated that firewood was collected from the forest of their communal land. It was indicated that sometimes they are forced to cut down most trees especially on events of death and ritual. They mentioned that trees such as Mokgalo and Motlhware are highly harvested because they are used by men for building, lighting and heating of a kgotla on events such as death and ritual. Forests are fundamental to the maintenance of a habitable biosphere, because they conserve biological diversity (Benneh, 1996). Forests also contribute to the small-scale agricultural productivity by providing food, medicine, fodder and shade for livestock and they are the suppliers of oxygen to human beings. When forests are lost or severely degraded their capacity to function as regulators of the environment is also lost increasing soil infertility hence the Environmental Conservation Act 73 of 1989 was introduced. The aim of the Act is to ensure that organizations undertake an Environmental well-being of the public.

Findings revealed that respondents with the highest cooking times a day were 62.2%. In Zimbabwe for example fuel wood is the most important domestic energy in the country and it is mainly used for cooking (SADCC, 1990:774).Findings revealed the highest percentage of homes without separate kitchens with 52.2% and 47.8% of homes with separate kitchens. This clearly shows that most respondents might be suffering from lung diseases due to cooking indoors which causes pollution. Cooking is one of the many responsibilities for women and girls, the family relies on the mothers for food, hence the say that a woman's place is in the kitchen. It was revealed by most respondents that 97.8% cooks 1-2 hours a day. Due to the use of biomass they cook breakfast which is normally soft porridge or pap served with milk and then uses the same fire to prepare for lunch. This is followed by 2.2% of respondents who cook above two hours, one of the reasons being that some have to brew sorghum beer.

The findings revealed that respondents with the highest percentage for number of cooking years is 47.78% for respondents above 15 years of cooking, followed by 23.89% for respondents with 6-10 years of cooking, together with 15.56% of respondents with 1-5 years of cooking. The least was 12.77% for respondents with 11-15 years of cooking. Table 2 shows that 38.3% is the highest by growing vegetables in their backyard gardens, followed by 33.3% with livestock production. In order to secure food for human and animal survival, agricultural activities such as growing crops and vegetables cannot be ignored. In South Africa, the cause of food insecurity is not due to a shortage of food but rather to an adequate access to food by certain categories of individuals and households in the population (Vogel & Smith, 2002). It is stated in the (Human Science Research Council, 2004) that the majority of South Africans buy their staple foods from commercial suppliers, rather than growing it themselves and therefore depends on having direct or indirect access of cash.

Table 1: Personal characteristics of respondents

Variables	Frequency	Percentages
Age		
Less 30	90	50
30-40	38	21.11
41-50	31	17.22
Above 50	20	11.11
Race		
Black	180	100
Gender		
Male	68	37.8
Female	112	62.2
Marital status		
Divorced	5	2.8
Married	43	23.9
Single	95	52.8
Cohabite	22	12.2
Widow	9	5.0
Widower	6	3.3
Number of Children		
1-3	102	56.67
4-6	21	11.67
Non-resigned	56	31.1
Language		
Tswana	170	94.4
Xhosa	8	4.4
Afrikaans	1	0.6
Level of education		
Primary	23	12.8
High	120	66.7
Tertiary	10	5.6
Types of employment		
Farm worker	134	74.4
Artisan	22	12.00
Government employment	18	10
Private employment	6	3.33

Variables	Frequency	Percentages
Types of housing		
Non response	75	41.7
RDP	109	60.6
Shack	21	11.7
Brick house	44	24.4
Mud house	6	3.3
Household size		
1-3	53	29.5
4.6	123	68.2
Above 6	4	2.3
Distance travelled for biomass collection		
Less than 1	2	1.2
1-3	162	89.91
Above 3	16	8.89
Biomass collection		
Own land	180	100
Cooking times per day		
1 hour	64	35.5
2 hours	110	61.2
3 hours	6	3.3
Home with separate kitchen		
Yes	86	47.8
No	94	52.2
Duration of cooking		
1-2hrs	178	97.8
Above 2hrs	4	2.2
Number of Cooking years		
1-5	28	15.56
6-10	43	23.89
11-15	23	12.77
Above 15	86	47.78

Table 2 indicates that biomass energy is the most preferred type of energy in Khaukhwe at 99.4% and it is important to almost all of them (91.1%). The second one is paraffin as it is important at 96.1% though it is not preferred because it is more expensive to buy and to transport as respondents indicated that they also have to pay for it separately. Electricity is not preferred by many due to its high price but they indicated that it is important to them and was rated 61.1%, followed by kerosene at 42.2%.

Table 2: Types, preferences and importance of energy used by respondents

	Yes	**No**
Kerosene	170[94.4]	10[5.6]
Paraffin	127[70.6]	53[29.4]
Electricity	144[80.0]	36[20.0]
Biomass	179[99.4]	1[0.6]
Solar power	1[0.6]	179[99.4]
	Preference	
	First	Second
Kerosene	76(42.2)	1(0.6)
Paraffin	0(0)	37(20.6)
Electricity	0(0)	2(1.2)
Biomass	179(99.4)	86(47.6)
Solar power	1(0.6)	0(0)
	Importance	
	First	Second
Kerosene	39(21.7)	140(77.8)

Paraffin	173(96.1)	6(3.3)
Electricity	110(61.1)	68(32.8)
Biomass	164(91.1)	8(4.4)
Solar power	1(0.6)	179(99.4)
Mode of transport		
	Yes	**No**
Public vehicle	100[100]	0[0]
Donkey/horse carts	171[95]	9[510]
Bicycle	162[90]	18[10]
Tractor	115[63.19]	65[36.2]
Use of biomass		
	Yes	**No**
Cow dung	175[97.2]	5[2.8]
Maize stover	60[33.3]	120[66.6]
Wood	177[98.3]	3[1.7]
Corn cob	151[83.9]	29[16.1]
Shrubs	76[42.2]	104[57.8]
Charcoal	59[32.6]	121[67.3]
Sorghum stall	12[6.7]	168[93.4]
Groundnut peels	15[8.3]	165[91.7]
Rice husk	2[1.1]	198[98.9]
Cotton wool stalk	5[2.8]	175[97.3]
Saw dust	28[15.6]	152[84.5]
Preference		
Cow dung	168(93.3)	
Maize stover	116(64.4)	
Wood	175(97.2)	
Corn cob	140(77.8)	
Shrubs	81(45.0)	
Charcoal	112(62.2)	
Sorghum stall	172(95.6)	
Groundnut peals	1(0.6)	
Rice husk	4(2.3)	
Cotton wool stalk	11(6.2)	
Saw dust	7(4.1)	
Importance		
Cow dung	138(76.7)	
Maize stover	175(97.2)	
Wood	180(100)	
Corn cob	79(43.9)	
Shrubs	180(100)	
Charcoal	180(100)	
Sorghum stall	180(100)	
Groundnut peals	180(100)	
Rice husk	180(100)	
Cotton wool stalk	180(100)	
Saw dust	180(100)	

Table 3 shows a list of 14 attitudinal statements towards the use of biomass. The respondents were asked to rate the statements using 5 Liker scale as follows; (strongly disagree), (disagree) (uncertain), (agree) and (strongly agree). Respondents were favourably disposed to the use of biomass through the following statements. Biomass is cheap (77.8%), biomass collection is gender biased (68.3%), biomass collection is time consuming (53.9%) and biomass is easily accessible (46.7%). It was strongly agreed that biomass is cheap, hence, the high dependency rate on it. As it is cheap and easily accessible the crucial role that biomass plays tend to be taken for granted hence (Garret 1968) put forward the view that where access to resources is free, people will tend to overuse them.

It was determined that energy collection is biased and this is emphasized by (Skutsch, 1995) who stated that in most countries, at least in the rural areas, it is primarily women who are responsible for gathering firewood or crop

residues for household fuel use, and subsequently also do the cooking (Skutsch, 1995).Generally fuel wood gathering can impact negatively on the social lives of women because the hours that they spend gathering firewood might otherwise be spent on productive work. The carrying of wood loads to their homes is physically draining as the load is normally carried on the head (Nadedja in IEA, 2000:71).

Table 3: Attitude towards the use of biomass

	SA	A	U	D	SD
Biomass is cheap	140(77.8)	40(22.2)	0(0)	0(0)	0(0)
Biomass is easily accessible	84(46.7)	96(53.3)	0(0)	0(0)	0(0)
Using biomass reduce the need for fossil fuel	52(28.9)	128(71.1)	0(0)	0(0)	0(0)
Biomass is a renewable energy	28(15.6)	149(82.8)	3(1.7)	0(0)	0(0)
All age groups can harvest and use biomass	50(27.8)	128(71.1)	2(1.1)	0(0)	0(0)
Biomass harvesting provides jobs	13(7.2)	130(72.2)	35(19.4)	2(1.1)	0(0)
Biomass is a reliable energy	15(8.3)	160(88.9)	5(2.8)	0(0)	0(0)
Biomass is locally produced	20(11.1)	158(87.8)	1(0.6)	0(0)	1(0.6)
Biomass is natural and has no carbon dioxide emissions	5(2.8)	60(33.3)	83(46.1)	26(14.4)	6(3.4)
Biomass is used on oven dryers to dry bricks	26(14.4)	153(5.0)	0(0)	0(0)	1(0.6)
Biomass energy sources are not privatized	0(0)	4(2.2)	15(8.3)	99(55.0)	62(34.4)
Biomass collection is time consuming	97(53.9)	80(44.4)	0(0)	1(0.6)	2(1.2)
Biomass collection is gender biased	123(68.3)	53(29.4)	0(0)	1(0.6)	3(1.7)
Biomass collection and storage is problematic in rainy seasons	67(37.2)	109(60.6)	0(0)	0(0)	4(2.3)

Table 4 indicates the purpose for which the different types of energy are used for cooking 100%, space warming 100%, flies repellants on pit latrines and toilet odour (97.2%), fertilizers for plant growth (96.1%), boiling water (92.8%), heating for ironing clothes (88.9%), warming animals (62.8%) and fodder for animals (61.7%). We all need energy in one form or another for day- to- day life for cooking, lighting, heating, and so. Energy can consequently be considered to be a basic need along with food, water and shelter (Kgathi, 1994).

Table 4: Purpose for the use of the following biomass

	Yes	No
Cooking	180(100)	0(0)
Space warming	180(100)	0(0)
Lighting	1(0.6)	179(99.4)
Heating for ironing clothes	160(88.9)	20(11.1)
Prevention of insect and diseases	91(50.6)	89(49.4)
Warming animals	113(62.8)	67(37.2)
Boiling water	167(92.8)	13(7.2)
Fodder for animals	111(61.7)	69(38.3)
Local business opportunities	124(68.9)	56(31.1)
Fertilizers for plant growth	173(96.1)	7(3.9)
Biogas for stoves and furnaces	119(66.9)	61(33.9)
Flies repellants on pit latrines and toilet odour	175(97.2)	5(2.8)

Table 5 shows the impact on harvesters at 100%, distance travelled for harvest is very long (100%), labour involved in harvesting (100%), harvesting biomass is time consuming (100%). Harvesting is done frequently (100%), health hazards encountered(100%), reduces agricultural activities use to time consumption is 99.4%, Most young girls leave school to run the chores of wood collection (98.3%), harvesters are vulnerable to thugs and rapists (97.8%), harvesters are exposed to harmful insects and snakes (97.8%) and to maintaining a sustainable forest is at 88.9%. The table shows that 98.3% of fire wood collectors agreed that young girls leave school for fire collection. This could be the reason why there is a high unemployment rate and less skillful youth. Interview showed that these women had no transport for biomass collection; hence they resorted to travelling on foot and head loading.

A diminishing supply of fuel wood automatically increases the demands made on women's labour time, this inevitably affects their health as well as that of their families. Women's labour time is a constantly undervalued resource

but it is the backbone of the rural economy, with men away from their homes working on mines, plantations, factories and in the transport sectors most of the peasant farming is effectively carried by women (Munslow, 1998).Fuel collection impacts negatively on women to an extend that some respondents indicated that they are being raped by strangers in the forest and are afraid to report the incidents as they will be victimized and become the laughing stock. The table indicates that 88.9% had no clue about forest sustainability. Hence (Huntley, 1989) says: "We do not wish anybody to be granted a license to plunder resources or to damage the environment and its life supporting processes indiscriminately. People must be educated about the importance of save guarding the interests of the future generations by protecting the environment today".

Table 5: Constraints in the use of biomass

Impact on harvesters	180(100)	0(0)
Distance travelled for harvest is very long	180(100)	0(0)
Labor involved in harvesting	180(100)	0(0)
Harvesters are exposed to harmful insects and snakes	176(97.8)	4(2.2)
Harvesters are exposed to cold, heat and rainy weather	113(62.8)	67(37.2)
Harvesters are vulnerable to thugs and rapists	176(97.8)	4(2.2)
Harvesting biomass is time consuming	180(100)	0(0)
Harvesting is done frequently	180(100)	0(0)
Health hazards	180(100)	0(0)
Reduces agricultural activities use to time consumption	179(99.4)	1(0.6)
Most young girls leave school to run the chores of wood collection	177(98.3)	3(1.7)
Public acceptance	6(3.3)	174(96.7)
Commercial value of other forest products	73(40.6)	107(59.4)
Maintaining a sustainable forest	160(88.9)	20(11.1)
Available supply of forest products	128(71.1)	52(28.9)

Table 6 shows the result of the Probit Model. This was used to determine the influence of socio-economic characteristics on the use of biomass by rural dwellers. The autonomous level of use of biomass by rural dwellers is -10.26. The model has a good fit and it is significant at 1% (χ^2 = 84263.00, df = 162, $p < 0.01$). Fourteen explanatory variables were significant while four variables were insignificant. The significant variables include Attitude (t =-4.112 , $p < 0.05$), Constraints (t = 3.815, $p < 0.05$), Age (t = 4.944, $p < 0.05$), Race(t = 2.234, $p < 0.05$), Gender(t = 3.406, $p < 0.05$), Language(t = -13.544, $p < 0.05$), Educational level(t =-8.189 , $p < 0.05$), Employment type(t = -10.115, $p < 0.05$), Dwelling type(t = 2.364, $p < 0.05$), Distance for biomass collection (t = 5.142, $p < 0.05$), Cooking times per day (t = -12.385, $p < 0.05$), Cooking Duration per meal (t = 14.882, $p < 0.05$), Cooking years (t = -9.846, $p < 0.05$) and Homes with separate kitchen (t = -7.908, $p < 0.05$).The Probit Model seeks to explain the probability of use of biomass by rural dwellers as a result of identified independent variables. The signs of the coefficients of independent variables and significance of the independent variables were used in determining largely the impact of each variable on probability of use of biomass by rural dwellers.

Table 6: Probit regression analysis for determinants of biomass use among rural dwellers

Parameter	Estimate	Std. Error	Z	Sig.
Attitude	-.098	.024	-4.112	**.000**
Constraints	.356	.093	3.815	**.000**
Age	.107	.022	4.944	**.000**
Race	2.480	1.110	2.234	**.025**
Gender	.730	.214	3.406	**.001**
Marital status	-.045	.070	-.652	.515
No of Children	.132	.110	1.198	.231
Language	-3.830	.283	-13.544	**.000**
Educational level	-1.193	.146	-8.189	**.000**
Employment type	-.120	.012	-10.115	**.000**
Dwelling type	.196	.083	2.364	**.018**
Household size	.013	.102	.129	.897
Distance for biomass collection	.667	.130	5.142	**.000**
Cooking times per day	-1.698	.137	-12.385	**.000**
Cooking Duration per meal	3.089	.208	14.882	**.000**
Cooking years	-.151	.015	-9.846	**.000**
Homes with separate kitchen	-1.249	.158	-7.908	**.000**
Intercept	-10.262	3.379	-3.037	**.002**
Chi-Square	84263.00			
df[a]	162			
Sig.	0.00			

4. Conclusion

Lack of access to clean and affordable energy is one of the core dimensions of poverty as it affects household health and levels of productivity. The use of low quality of biomass fuels by the poor for instance is known to have negative effects on health, arising from the smoke and respirable particulates. Indeed, poverty is characterized by low consumption of energy that is predominantly an invariably signals and absence of choice. Therefore the government is faced with a duty to provide rural areas with sufficient and less harmful energy forms to meet the objectives of rural development

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