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Contributions of Fuelwood to Household Income and its Effect on Sustainable Forest Management in Northern Taraba

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Abstract:-Fuel-wood contributes to the household income of the inhabitants of Northern Taraba. However, the extent or the exact amount of income is not known, studied or documented in the study area and hence the need for this study. A multi-stage sampling technique was adopted for this study and at 30% sampling intensity, a total of 270 respondents were randomly selected for this study. Two hundred and seventy semi-structured questionnaires were developed, validated and administered to the respondents using the method of Adesoye, (2004) and Diaw et al. (2002) to generate data for this study with only 265 retrieved. Data generated was analysed using simple percentages, t-test and Logistic regression analysis at $\alpha_{0.05}$. The result on sources of energy used for livelihoods of the inhabitants of Northern Taraba indicated that, fuel-wood energy have 170 (64.2%); Gas 25(9.4%); Electricity, 20(7.5%) and Kerosene, 50(18.9%) respectively (Table 1). The result on the contributions of fuel-wood to the income of the inhabitants of Northern Taraba indicated that, an average monthly income of ₦15,000 was derived from the sales of fuel-wood while an average monthly income of ₦10,000=00 was derived from other sources by the respondents in the study area. T-test analysis showed significant differences between the two sources of income at P<0.05 respectively (Table 2). The result of fuel-wood harvesting methods indicated cutting, 80(30.2%); felling, 74(28.0%); digging/uprooting, 30(11.3%); Hand pulling, 25(9.4%) and Gathering/ picking56,(21.1%) respectively(Table 3). Similarly, the result on the effect of fuel-wood harvesting methods on sustainable forest management showed; Destruction of animals or wildlife habitat, 40(15%); Erosion, 60(22.6%); Loss of biodiversity, 55(20.8%); Trekking long distances before sighting trees used as fuel-wood 35(13.2%); Escape of large animals, 30(11.3%) and Late onset and cessation of rainfall, 45(17%) respectively(Table 3). The result of logistic regression analysis on reasons for the preference of fuel-wood to other energy sources showed; affordability, availability, reliability, Household size and Educational status with the highest odds – ratios of 2955.74; 60.08; 7.21; 6.84 and 3.71 while variables such as efficiency, had odds – ratio 0.02; safety, (0.00); marital status, (0.01); sex, (0.00) and age (0.00) respectively (Table 4). The findings from this study indicated that, fuel-wood is the most widely used sources of domestic energy. Also, an average sum of ₦15,000.00 per month was gotten from the sales of fuel-wood in the study area. Similarly cutting, felling, digging/uprooting, hand pulling, gathering/picking are used in harvesting fuel-wood in the study area. While destruction of animal habitats, erosion, loss of biodiversity, trekking long distances to harvest fuel-wood, escape of large animals into neighbouring Cameroun, late onset and cassation of rainfall were the effects of fuel-wood harvesting on sustainable forest management in the study area. Similarly, affordability, availability, reliability, household size and educational status were found to be the reasons for the preference of fuel-wood energy to other sources of energy for livelihoods in the study area. Based on the major findings above, the following are recommended; Avoid felling and digging /uprooting; the use of power chain saws to cut or fell tree should also be regulated; Seedlings of trees used as fuel-wood should be raised by government and non governmental organisations for onward delivery to farmers for planting on the farms to reduce pressure on wild trees etc to mention but a few.

Keywords:- *Contributions, Fuel-Wood Energy, Harvesting Method, Household Income And Sustainable Forest Management.*

I. INTRODUCTION

Fuel-wood is a fibrous rigid material of plant origin broadly classified as hard or softwood. It consists of any woody biomass used to fuel a small fire (Arnold *et al.*, 2006), Fuel-wood energy therefore refers to any energy source that comes from woody biomass. They include firewood, charcoal, wood pellets and saw dust respectively. They may be harvested from trees and shrubs in forest, farmlands, homesteads, common land outside forest and by-products of forest industries. In some cases, fuel wood are collected from dead woody materials (Onoja and Emodi, 2012). Fuel wood has been a major source of energy for many countries across the globe. (Adeoti *et al.*, 2001)).It is the oldest energy source worldwide (Ogunkunle and Oladele, 2004). Fuelwood energy is very important to human's continued existence or survival as it is required for cooking, heating and lighting (Ogunsanwo and Ajala, 2002). Over the years, the demand has increased with increase in human population (Ogunsanwo and Ajala, 2002).

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The rate at which trees are fell is more than the rate at which they are planted today. This is due largely to the high demand for fuel wood as a result of the soaring prices of electricity, kerosene and gas used as domestic energy in Taraba State (Zaku, 2013a). Over-reliance on fuel wood may lead to shortages of wood in the forest, reduction in biodiversity and nutrient loss (Heltberg *et al.*, 2000, 2005). In the past, the effects of fuel wood harvesting was minimal due to low human population (Zaku, 2013b) However, as a result of population increase, man's dependence on wood as a source of domestic energy started showing signs of inadequacy (Momodu, 2013).The high level of poverty and the soaring prices of kerosene, electricity and gas had forced a lot of people to depend on fuel wood extraction as a means of domestic energy requirement. This may take three forms as follows:

Type or species of wood not often used by households but now being used. Preference of fuel wood energy to other sources of energy due to cash shortage. Increased sales of fuel wood in rural and urban areas and markets (Zaku, 2013a). Fuel wood are used to generate income, food preparation, warmth, smoking meat and fish brewing local beers, firing bread and pot, oil extraction, parboiling of rice paddy and burning of bricks respectively (Adeniyi and Felix, 2011).However, the extent of the above contributions in monetary times is not studied or documented in Taraba State and hence this study. The study therefore provided information on the contributions of fuel wood to the livelihoods of the inhabitants of Northern Taraba and its effect on sustainable forest management in Taraba State.

Majority of the inhabitants of Northern Taraba are low income earners. To argument income shortages, many took to the exploitation of fuel wood for domestic cooking, smoking of fish and bush meat for sales. They are also used for warmth, bricks burning, brewing local beer, bread and pottery production as well as oil extraction from seeds. Fuel wood extraction in Northern Taraba has gone beyond mere gathering of dead wood to a deliberate and wanton cutting of trees with power saws at a large scale felling exercises on daily basis. The indiscriminate exploitation of fuel wood goes un-abated and the exploiters seem not to be bothered about the effects of their activities on sustainable forest management. In Taraba State, fuel wood accounted for major part of the energy sources for domestic needs. More people depend on the use of fuel wood as source of energy and more trees are fallen for such usage. This can be substantiated by piles of felled logs seen on many streets in Taraba State meant for domestic and industrial use.

Fuel wood contributes significantly to community livelihoods in Taraba State in terms of income, energy for house food preparation, warmth, smoking of fish and bush meat, brewing, local beer, bread and pottery production, oil extraction, parboiling of rice, burning of bricks etc to mention but a few. However, the extent of this contribution is not studied or documented in Taraba State. This study therefore intends to bring to the public glare, the contributions of fuel wood energy to the livelihoods of the inhabitants of Northern Taraba and its effect on sustainable forest management.

II. MATERIALS AND METHODS

- *Description and Location of the Study Area:-*

Taraba State is located in the North-Eastern part of Nigeria. It was named after the Taraba River which traverses the southern part of the state. Taraba State is located between Latitude $6^0$30' & $9^0$36'N and longitude $9^0$10' & 11°50'E. The State was created out of the former Gongola State on 27th August, 1991 by the military government of General Ibrahim Babangida. Taraba state is bounded in the West by Plateau and Benue states and on the East by Cameroon. The State has sixteen local government areas. It is bounded by Bauchi and Gombe State on the Northern part, Plateau and Nasarawa states on the Western part and Adamawa on the eastern part. Taraba state has a population of 2,300,736 (NPC, 2006; TSD, 2014).

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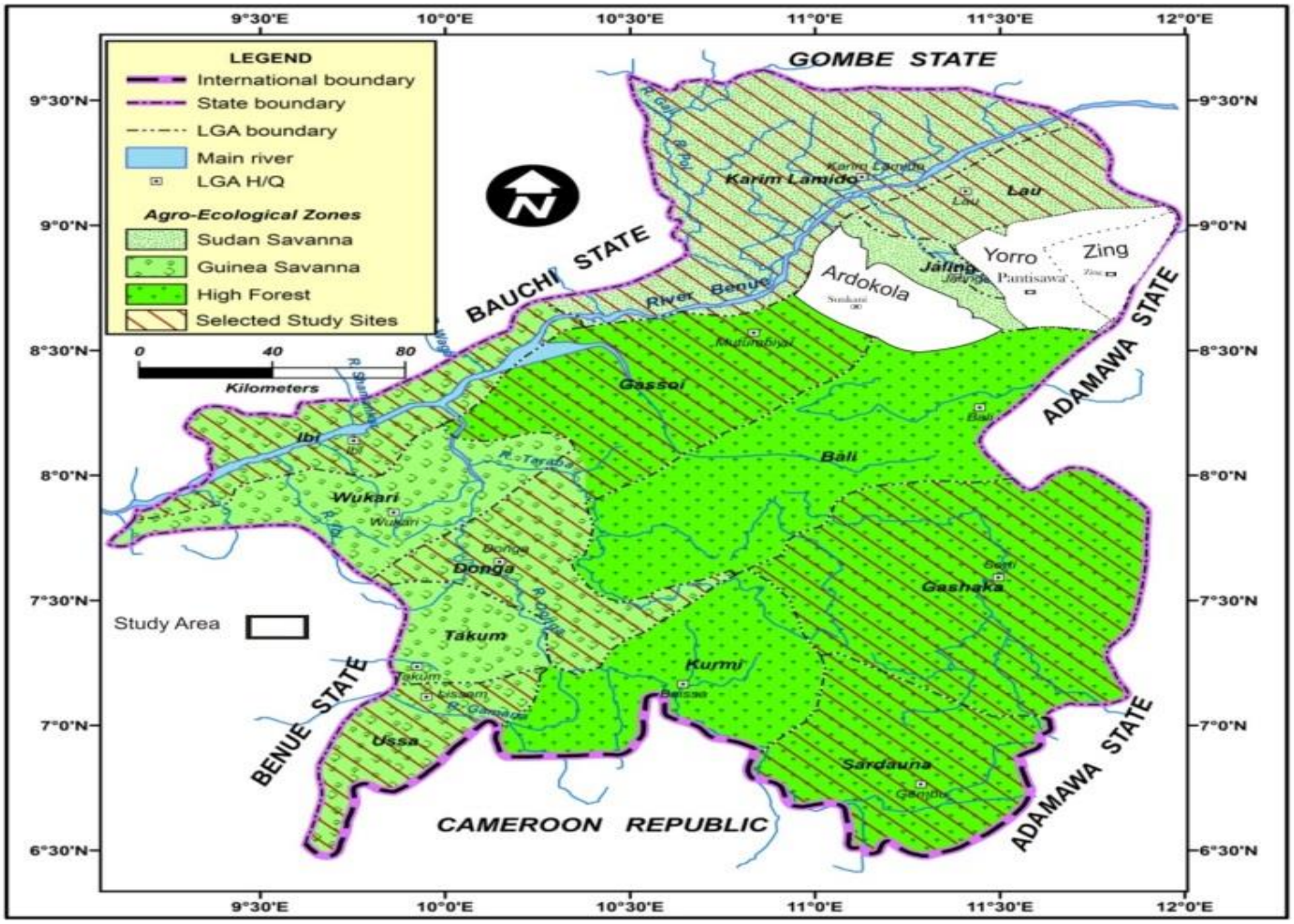

Fig 1 Map of Taraba State Showing The Study Area
Source: Zaku, (2013)

➢ *Sampling Techniques:-*

Multi-stage sampling techniques were used in the selection of sampling population in the study area. The study area has six local government areas namely, Ardo Kola, Karim-Lamido, Lau, Jalingo,Yorro and Zing. In the first stage, three out of the six local government areas in the NorthernTaraba senatorial zone were randomly selected. The local government areas areYorro, Zing, and Ardo Kola. In the second stage, three wards were selected randomly from each selected local government areas given a total of 9 wards for the study. In the third stage, a random selection of thirty (30) respondents from each of the nine (9) wards thereby bringing the total to 270 respondents for the study. The primary data were collected using semi structured questionnaires. A total of 270 copies of semi-structured questionnaire were developed, validated or pre-tested before being administered to respondents from the selected wards using the method of Adesoye, (2004) and Diaw *et al.* (2002). Data generated were analysed using simple percentages, t-test and Logistic regression analysis at $\alpha_{0.05}$ The mathematical model for t-test is as follows;

$$t = \frac{\overline{X_A} - \overline{X_B}}{\sqrt{\frac{S^2(nA+nB)}{(nA)(nB)}}} \quad 1$$

Where;

- A = first group (income from other sources)
- B= second group (income from fuel wood)
- $\overline{X_A}$= Mean of group A (income from other sources)
- $\overline{X_B}$= mean of group B (income from fuel wood)
- $\overline{X_A}$and$\overline{X_B}$=Arithmetic means for groupA'' and ''B''
- nA and nB =number of observations in group A and B
- S^2 = pooled within group variances (for independent samples with equal variances).

Similarly, the mathematical model for Logistic regression is as follows:

$$\text{Logit (p)} = \log\left(\frac{p}{1-p}\right) = \log (p) - \log (1\text{-P}) \ldots \ldots \text{equation 2}$$

The simplest form of logistic model is expressed as;

$$\text{Logit (Pi)} = a+bxi \ldots\ldots\ldots\ldots \text{equation 3}$$

Where,

Pi = Probability of contributions of fuel wood to the livelihoods of the inhabitants of Northern Taraba.

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Xi = Vector of predictor or independent variables (Contributions of fuel-wood to the livelihoods of the inhabitants of Northern Taraba.

It can also be represented as follows;

$$\text{Logit}\left(\frac{p}{1-p}\right) = Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 \ldots\ldots\ldots\ldots + \beta_n X_n \text{----------equation 4}$$

Where;

β_o β_1 β_2 …… β_n = Regression coefficient or model parameters

The determinants for the preference of fuel wood to other sources of energy investigated were affordability, reliability, efficiency, safety, availability, Educational status, Marital status, sex, age and household size respectively.

Thus:-

X_1 = AffordabilityX_2 = ReliabilityX_3 = EfficiencyX_4 = High safetyX_5 = Availability

X_6 = Educational statusX_7 = Marital statusX_8 = SexX_9 = AgeX_{10} = Household size

Y= Determinants for the preference of fuel wood to other sources of energy used by the inhabitants of Northern Taraba.

III. RESULTS AND DISCUSSION

➢ *Sources of Energy:-*

The result on sources of energy used by the inhabitants of Northern Taraba indicated that, fuel wood energy had 170 (64.2%) Kerosene,50(18.9%); Gas 25(9.4%); Electricity, 20(7.5%) and respectively(Table 1).

Table 1 Sources Of Energy Used By The Inhabitants Of Northern Taraba

S/N	Variables	No. of respondents	Percentage (%)
1	Fuel-wood	170	64.2
2	Gas	25	9.4
3	Electricity	20	7.5
4	Kerosene	50	18.7
	Total	**265**	**100**

Source: Field Survey, 2022

The high number recorded of fuel wood and kerosene implies that they are the most widely used energy sources in the study area. The findings corroborates Haile et *al.*, 2009; May-Tobin, (2011);Amuah, (2011) and Audu, (2013)respectively.

➢ *Contributions of Fuel-Wood To The Income of The Inhabitants of Northern Taraba:-*

The result on the contributions of fuel-wood to household income of the respondents per month in the study area indicated that, an average monthly income of ₦15,000 was derived from the sales of fuel-wood while an average monthly income of ₦10,000=00 was derived from other sources by the respondents in the study area T-test analysis also showed significant differences between the two sources at P<0.05 respectively (Table 2)

Table 2 Contributions of Fuel-Wood To The Income of The Inhabitants of Northern Taraba

Sources of income	Average	±sd	p-value
Income from fuel-wood	15,000=00	3391.75	0.001
Income from other sources	10,000=	214.23	

Source: Field Survey, (2022)

This means that, fuel-wood contributed more to community livelihoods than income from other sources of the respondents in the study area. The decision rule is that, when P<0.05 significant difference exist between the income from the two sources and when P>0.05, it means there is no significant differences between the income from the two sources. The findings of this study corroborates Arnold et al., (2016) and Zaku *et al.,* (2013) respectively.

For instance, a pick up van of fuel-wood now cost between ₦12,000.00to₦15,000.00 while a bag of charcoal is now sold for ₦1,500.00 to ₦2,000.00 respectively.

Similarly, kekenapep is sold for ₦7,500.00 while Kuskus full with fuel-wood goes for ₦2,500.00 to ₦3,500.00 respectively. Fuel-wood vendors equally sale for ₦200.00, ₦500.00 and ₦1,000.00 respectively (Table 2)

This explains how fuel-wood vendors earn an average of ₦15,000.00 every month particularly during the dry season when most of trees had dried up. Fuel-wood are either sold directly by the fuel harvesters or charcoal producers, fuel-wood vendors retailers (middlemen) or wholesalers respectively. The above corroborated Adeoti *et al.,* (2001) and Zaku *et al*., (2013) respectively that both concluded that, fuel-wood contributes significantly to household income.

➢ *Fuel wood harvesting methods and its effect on sustainable, forest management*

The result of fuel-wood harvesting methods and its effect on sustainable forest management indicated that; cutting had 80 respondents comprising of 30.2% followed by felling, 74(28.0%) and digging/uprooting; 56(21,1%); Gathering/picking 30(11.3%) respectively while hand pulling branches25(9.4%), are shown in (Table 3). Similarly, the result on effect of fuel-wood harvesting methods on sustainable forest management includes; Erosion, 60(22.6%);Loss of biodiversity, 55(20.8%);late onset and cessation of rainfall, 45(17.0%) Destruction of animals or wildlife habitat, 40(15.0%);Trekking long distances before sighting trees used as fuel-wood 35(13.2%); Escape of large animals, 30(11.3%) (Table 3)

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Table 3: Fuel-Wood Harvesting Methods And Its Effect On Sustainable Forest Management In The Study Area.

S/N	Variables	No.of respondents	Percentage(%)
1	Fuelwood harvesting methods		
	Cutting	80	30.2
	Felling	74	28.0
	Digging/uprooting	56	21.1
	Hand pulling branches	25	9.4
	Gathering/picking	30	11.3
	Total	265	100
2	Effect of Fuel wood harvesting methods on sustainable forest management.		
	Destruction of animal/wildlife habitat	40	15.0
	Erosion	60	22.6
	Loss of biodiversity	55	20.8
	Trekking long distances before sighting trees used as fuel-wood	35	13.2
	Escape of large animals	30	11.3
	Late onset and early cessation of rainfall	45	17.0
	Total	265	100

Source: Field Survey, 2022

The high number recorded of cutting, felling, digging and uprooting were the most widely used fuel wood harvesting methods. These harvesting methods are destructive and are not sustainable. This is because; they tend to destroy the entire tree. The findings of this study agreed with Ebe, (2014), Zaku, (2013) and Ujih *et al.* (2016) respectively. Also, the high number and percentages recorded of destruction of animals and wildlife habitat, erosion, Loss of biodiversity, Late onset and cessation of rainfall, trekking long distances before sighting trees used as fuel wood and the escape of large animals into neighboring countries implied that, they are the effects fuel wood harvesting methods on sustainable forest management in Northern Taraba. This finding corroborates Zaku, (2013) respectively

➢ *Reasons For The Preference of Fuel-Wood To Other Sources of Energy By The Inhabitants of Northern Taraba*

The results of logistic regression analysis on reasons for the preference of fuel-wood to other sources of energy, indicated that; affordability, availability, reliability, Household size and Educational status had the highest odds – ratios of 2955.74; 60.08; 7.21; 6.84 and 3.71 respectively (Table 4.6). Similarly, variables such as efficiency had odds – ratio 0.02; safety, (0.00); marital status, (0.01); sex, (0.00) and age (0.00) respectively (Table 4).

- PFW = 31.04 +7.99AF+1.98RB – 2.52EF – 28.81ST +4.09AV+1.92EDS –3.99MS – 38.42SEX – 26.16AGE+1.31HHS 4
- n = 265, final loss = 18.78, Chi-square
- (df, 10) = 298.29, p = 0.00
- Odd ratio (unit change): Constant (1.31): AF(2955.74); RB(7.21); EF(0.02); ST(0.00); AV(60.08); EDS(6.84); MS(0.01); SEX(0.00); AGE(0.00); HHS(3.71) 5

Table 4 Logistic Regression Analysis Of Reasons For The Preference Of Fuel Wood To Other Sources Of Energy Used For Livelihoods In The Study Area

Dependent variables: Reasons for the preference of fuel-wood (Presence =1; Absence =0)			
S/N	**Independent variables**	**Coefficient**	**Odds ratio**
1	Affordability (AF)	7.99	2955.74*
2	Reliability (RB)	1.98	7.21*
3	Efficiency (EF)	-1.52	0.02ns
4	Safety (ST)	-28.81	0.00ns
5	Availability (AV)	4.09	60.08*
6	Educational status (EDS)	1.92	6.84*
7	Marital status (MS)	-3.99	0.01ns
8	Sex (SEX)	-38.42	0.00ns
9	Age (AGE)	-26.16	0.00ns
10	Household size (HHS)	1.31	3.71*
Model $x^2(df = 10) = 298.29 *$			

Note P,0.05 = Not Significant* = Significant

The highest odds – ratios recorded for affordability, availability, reliability household size and educational status implied that, they are the reasons for preference of fuel-wood to other sources of energy used for community livelihoods in the study area. The decision rule is that, variables that have odds ratios with negative values or values lower than two are not reasons for the preference of fuel-wood to other sources of energy used for community livelihoods in the ratios two or

greater than two are reasons for the preference of fuel-wood to other sources of energy used for community livelihoods in the study area. This findings corroborates Deeks, (1996) and Bland and Altman, (2000) that, logistic model provides information on the consequence of one variable on the other. In the case, reasons for the preference of fuel-wood to other sources of energy used for livelihoods in the study area. The study also agreed with the submission of Gbadegeshin and Olorunfemi, (2011) and Specht *et al,* (2015)

IV. SUMMARY AND CONCLUSION

The findings from this study indicated that, fuel wood, gas, electricity and kerosene were the major sources of energy used for livelihoods with fuel wood being the most widely used. Also, a total of 22 trees belonging to 15 families were found to be used as fuel wood for livelihoods in the study area. Also, an average sum of ₦15, 000.00 per month was gotten from the sales of fuel wood by the inhabitants in the study area. Similarly, Fuel wood harvesting methods such as cutting, felling, digging/uprooting, hand pulling, gathering/picking were used in the study area. While destruction of animal habitats, erosion, loss of biodiversity, trekking long distances to harvest fuel wood, escape of large animals into neighbouring Cameroun, late onset and cassation of rainfall were the effects of fuel wood harvesting methods on sustainable forest management in the study area. Also, affordability, availability, reliability, household size and educational status were found to be the reasons for the preference of fuel wood energy to other sources of energy for livelihoods in the study area

RECOMMENDATIONS

- *Based on the major findings above, the following are recommended;*

- Avoid felling and digging /uprooting as they are capable of killing the entire plant or tree. The use of power chain saws to cut or fell tree should also be avoided.
- Seedlings of trees used as fuel wood should be raised by government and non-governmental organisations for onward delivery to farmers for planting on the farms. When farmers plant trees used as fuel wood in their farms and around their houses, the pressure on wild trees will be reduced.
- Government should reduce and control the cost of alternative sources of energy like gas, kerosene and electricity.
- Government should introduce, improve and affordable stores. Government should introduce tree planting as a policy.
- Government should create alternative sources of income by training respondents on various skills acquisitions.
- Government should identify and monitor charcoal producers.
- Government should issue license to fuel wood harvesters and processor to check their excesses.
- Government should enhance the implementation of forest laws and policies

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