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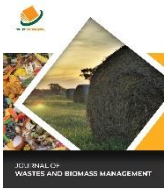

RESEARCH ARTICLE

# APPRAISAL OF PER CAPITA CONSUMPTION OF CHARCOAL AND FIREWOOD AS AN ALTERNATIVE ENERGY SOURCES FOR DOMESTIC USAGE IN KEFFI NASARAWA STATE NIGERIA

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**ABSTRACT**

The simple way to utilized forest resources is to make use of their by-products (firewood and charcoal) in our households. Africa suffered a great deal of energy supply. Nigeria has limited electricity supply in recent years. Gas, kerosene and LNG are exorbitant that poor people cannot afford. The rate of poverty increases especially in a mostly rural community in Nigeria as well as Africa due to bad leadership that common people have no resources to depend on except forest resources where women and children go to bushes. This study assesses the per capita consumption of both the firewood and charcoal daily, weekly, monthly and annually. The rates of consumption determine the usage of fuelwood. The regression analyses were employed to statistically verify the rate of fuelwood consumption. The result indicates that there are high rates of consumption per capita per day (charcoal 0.20kg, firewood 0.09kg), per capita per week charcoal 9.9kg, firewood 4.48kg), per capita per month ( charcoal 181.9kg; firewood 82.5kg) and charcoal 26,937kg firewood 12,042kg). This indicates that people are highly destroying forest daily and alter the natural system of the environment for the sake of fuelwood consumption.

**KEYWORDS**

forest resources, households, firewood, consumption, community.

## 1. INTRODUCTION

### 1.1 Fuelwood Features in an Environmental Overview

Environmental aspects of fuelwood production and energy use are expanded over a wide spectrum of applications, from the local land use up to global climate change, and applications in smoky kitchens to electricity generation up to large-scale power plants (Arabatzis et al., 2012). In parallel, environmental impacts of fuelwood production and energy use are valued both as positive and as negative, thus the environmental footprint of these impacts should be an integrated component of any contemporary fuelwood energy scheme upon energy policymaking the Western Ghats Biodiversity Information System (Ramachandra and Suja, 2006).

### 1.2 Wood Energy

Energy is a limiting commodity for many communities in the developing world, and the rural communities in Africa are highly dependent upon wood as their primary energy source (Arnold and Jongma, 1977). For example, in South Africa, 12% of the total energy consumption of the country (i.e domestic and industrial) is extracted from the wood source, while in countries such as Burkina-Faso, Ethiopia, Mali, Tanzania and Zambia, this figure is over 90% (Basson, 1987). The few states that have been done on that wood utilization have achieved issues concerning sustainable utilization, history of legalized protection of wood resources, the economics of fuelwood usage, and future energy demand (Basson, 1987; Du Plessis, 1995; Liengme, 1983). No study in Africa has examined the impact of fuelwood removal on components of biodiversity other than the wood resources itself, even though it has been recognized that this practice may have consequences for conservation (Von Maltitz and Shackleton, 2004). Effective conservation practice demands the maintenance of biological diversity and ecological processes within the constraints of sustained resources utilization (Bahru et al., 2012). Few areas in indigenous forest in Southern Africa are free from exploitation, both commercial and subsistence, and extensive fragment of natural forests has occurred.

Round wood used in energy production is comparable in quantity with industrial round wood. Energy production using wood includes traditional heating and cooking with fuelwood and charcoal, heat and power production in the forest industry (usually using processing wastes such as black liquor from pulp production) for own use or sale to others, and heat and power generation specifically designed power facilities (Baiyegunhi and Hassan, 2014). Statistics on energy production from wood are difficult to obtain because of this diversity of uses and the high share of informal

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production. Furthermore, the two main agencies that collect these statistics FAO and the International Energy Agency (IEA) present different figures because of different definitions and primary data sources. IEA presents biomass energy production figures that include other types of biomass besides wood (i.e. agricultural residues and dung) (Larinde and Olasupo, 2011). Its statistics also include heat and power generation in the forest industry and by commercial energy producers, which are not fully captured in FAO statistics. Trends and projections for biomass energy production estimated from a combination of these two data sources reveal an increase in global production from about 530 million tonnes of oil equivalent (Zulu and Richardson, 2013).

According to the Forest Resources Assessment (FRA), Country Report Nigeria 2005 total wood removals from forests in 2005 amounted to 86,626,797 m3, and removals for wood fuel from forests in the year 2005 were 72,710,935 m3, the difference being made up by industrial round wood, which accounted for 13,915,862 m3 (Ogundele et al., 2011). The most important sources of fuel, which are the necessities for mankind, are fuelwood (charcoal and firewood), petroleum and peat. Of these, wood makes an outstanding fuel as it is 99% flammable if completely dry (Bahru et al., 2012; Triebel and Damm, 2008). More than 2 billion people use wood, charcoal, dung or agricultural residues as the primary fuel for their cooking and heating needs, leading to significant health, economic and environmental consequences (Arabatzis et al., 2012). Burning wood or agricultural residues produces smoke with a variety of irritant pollutants, some of which are known carcinogens. More than 1.5 million deaths a year are caused by acute respiratory infections from breathing smoke from indoor cooking fires (Neina et al., 2020).

Women and children are generally exposed to the greatest levels of pollutants and it is children who suffer the greatest health risk. Respiratory infections are the leading cause of death of young children worldwide. Biomass accounts for 73% of total domestic energy consumption and about 87% of households use firewood or charcoal with 2 kg of charcoal or 4.6 kg of firewood per day. More than half of the domestic energy needs are met by combustible renewable resources and waste, mainly in the form of biomass. It must also be noted that energy use depends upon their accessibility/availability as well as energy costs. Seen the poverty of developing countries and the price increase for petroleum products, firewood is still the most used fuel in rural areas, charcoal is mainly intended for large cities (Zulu and Richardson, 2013). For example, in Abidjan, 90% of the population use the charcoal produces in households (Hendrickson and Horvath, 2000). Poverty conditions are also worsened through the health and quality of life impacts associated with traditional biomass fuels.

The few states that have been done on that wood utilization have achieved issues concerning sustainable utilization, history of legalized protection of wood resources economics of fuelwood usage, and future energy demand (Shackleton, 1993). One of the major and most renewable natural resources available to the earth and man at large is forest and its products. The burning of wood is currently the largest use of energy derived from solid fuel biomass. Fuelwood can be used for cooking and heating, and occasionally for fueling steam engines and steam turbines that generate electricity. Fuelwood may be available as firewood, charcoal, chips, sheets, pellets, and sawdust. The most important sources of fuel, which are the necessities for mankind, are fuelwood (charcoal and firewood), petroleum and peat. Of these, wood makes an outstanding fuel as it is 99% flammable if completely dry (Larinde and Olasupo, 2011). The particular form used depends upon factors such as source, quantity, quality and application. Africa is highly dependent upon wood as its primary energy source (Arnold and Jongma, 1977). For example, in South Africa, 12% of the total energy consumption of the country (i.e domestic and industrial) is extracted from the wood source, while in countries such as Burkina-Faso, Ethiopia, Mali, Tanzania and Zambia, this figure is over 90% (Basson, 1987).

## 2. Consumption of Fuelwood in Nigeria

"The consumption of fuelwood and charcoal remains based on the early data by FAO as reported by EMRD (1991). This is based on a per capita fuelwood and charcoal consumption of 0.5 t/cap/year and 0.2 t-charcoal/cap./year and projected for the national population as available from the 1991 population census at projected at 2.8% growth rate per year" (Laing and Obioh, 1994). However, due to rising prices for fossils fuels, a massive shift from "modern" fuels like Kerosene and LPG back to fuelwood and charcoal has been taking place. To calculate the consumption of wood fuel, the amounts of wood used for charcoal making and fuelwood have to be summed up. If we apply a weight-related conversion factor of 4.5 for charcoal making (the volume-related FAO default value is 6:1), wood fuel consumption is about 1.4 kg/head/day; or the energy equivalent thereof in fossil fuels. A study reported a fuelwood consumption of 360 kg/person/year (excluding wood used for making charcoal) in neighboring Kano State (Cline-Cole, 1994). There is an obvious competition between surface needs for agriculture and wood production.

## 3. The Shift From Fossil "Modern" Forms of Energy Like Kerosene or LPG Back to Fuelwood

"The unsustainable level of production of fuelwood in Nigeria is likely to continue for some time as long as the energy crisis facing the country remains unresolved. The country still witnesses an erratic supply of petroleum products (Kerosene and Gas), and when available the prices are beyond the reach of ordinary people. The implication is not far-fetched, as more people will resort to fuelwood, which is already in short supply" FAO 2003, Experience of National Forestry Programmes in Nigeria (FAO, 2003). Of the myriad causes of depletion of forests, increasing fuelwood usage has been identified as one of the biggest threats to forest covers (Agarwala et al., 2016). Over 80% of rural and urban inhabitants in southern Africa, for instance, use fuelwood as a primary or secondary energy source (Baiyegunhi and Hassan, 2014). Fuelwood users access woodlands and forests either for domestic and economic gains. Some people and institutions within the community control resource access while others maintain it through those who have control. Rural fuelwood collection by gender is determined by the purpose for which it is used. Generally, women and children are mainly involved in fuelwood collection for domestic use while men collect wood for sale (Triebel and Damm, 2008).

### 3.1 Types of woods used as charcoal fuelwood

Acacia caffra
Acacia karoo
Dalbergia amarta
Dalbergia obovata
Grewia lasiocarpa
Ptaeroxylon obliquum
Rhus chirindensis
Schotia branchypetala
Ziziphus mucronata

**Figure 1:** Types of fuelwood (Charcoal) used in the study area

### 3.2 A few of the uses of activated charcoal with some evidence include the following.

- Kidney health. Activated charcoal may be able to assist kidney function by filtering out undigested toxins and drugs
- Intestinal gas
- Water filtration
- Diarrhea
- Teeth whitening and oral health
- Skincare
- Deodorant
- Skin infection

**Figure 2:** Fuelwood (firewood) found in the Study Area

### 3.3 Implication of the use of Charcoal

According to the World Health Organization, 1.5 million people die every year from respiratory diseases related to smoke inhalation; most of them women and children. The use of biomass fuels like firewood for cooking or heating leads to high levels of indoor air pollution; especially when burned on traditional stoves or open fires indoors. The use of unsafe or inappropriate fuel sources (e.g., plastic; waste) can also lead to diseases. Women spend an average of three to seven hours per day near the stove preparing food. Young children are often carried on their mother's back or kept close to the warm hearth. Consequently, infants spend many hours breathing indoor smoke during their first year of life when their still-developing lungs make them particularly vulnerable to hazardous pollutants. Fifty-six percent of all indoor air pollution attributed deaths occur in children under five years of age (WHO). The inefficient burning of solid fuels on an open fire or traditional stove indoors creates a dangerous cocktail of hundreds of pollutants, primarily carbon monoxide and small particles, but also nitrogen oxides, benzene, butadiene, formaldehyde, polyaromatic hydrocarbons and many other health-damaging chemicals.

## 4. Result and Discussion

Table 1, a total of 24.25kg was obtained from 120 respondents. The charcoal usage, the per capita per day consumption is 0.20kg. While, for firewood consumption, the total per capita per day for 120 respondents is 11kg. And the per capita per day consumption is 0.09kg.

Charcoal = 24.25kg÷120 = 0.20kg per capita per day

Firewood = 11kg÷120 = 0.09kg par capita per day

**Table 1:** Amount of charcoal and firewood consumption per capita per day

| No of Respondent | Amount of Charcoal in kg Total Per Capita per Day | Amount of firewood in kg Total Per Capita per Day |
|---|---|---|
| 10 | 3.4 | 1.4 |
| 12 | 3.25 | 1.6 |
| 13 | 3.5 | 1.7 |
| 17 | 2.7 | 1.0 |
| 18 | 3.1 | 1.7 |
| 20 | 4.5 | 1.7 |
| 30 | 3.8 | 1.9 |
| Total 120 | 24.25 | 11 |

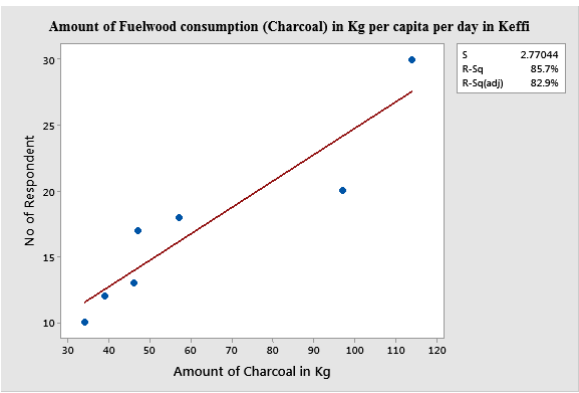


**Figure 3:** $R^2$ showing Charcoal consumption in Keffi

Figure 3 and 4 indicates both the per capita per day usage of charcoal and firewood in Keffi. The rapidity of the charcoal use is more than that of firewood base on the illustrated scattered dots.

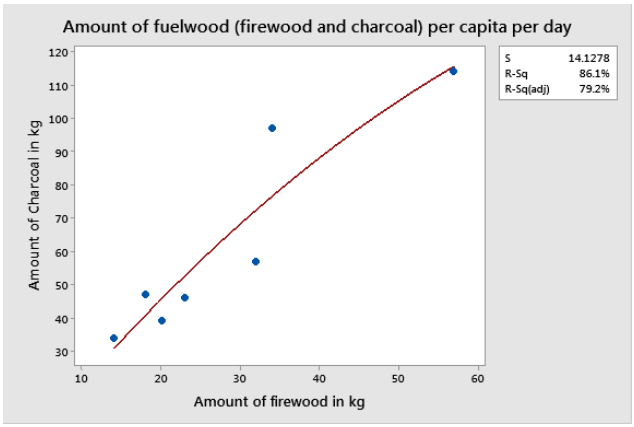


**Figure 4:** $R^2$ showing Firewood consumption in Keffi

Table 2, a total of 169.75 was obtained from 120 respondents. For the charcoal usage, the per capita per day consumption is 1.41kg multiply by the number of days in a week (7) which is 9.9kg. While, for firewood consumption, the total per capita per day for 120 respondents is 77kg. And the per capita per week consumption is 0.64kg multiply by the number of days (7) 4.49kg.

Charcoal = 169.75kg÷120 = 1.41kg.

1.41kg×7 = 9.9kg per capita per week

Firewood = 77kg÷120 = 0.64kg.

0.64kg×7 = 4.48kg per capita per week

**Table 2:** Amount of fuelwood (firewood and charcoal) per capita per week

| No of Respondent | Amount of Charcoal in kg Total per capita per week | Amount of firewood in kg Total per capita per week |
|---|---|---|
| 10 | 3.4*7 = 23.8 | 1.4*7 = 9.8 |
| 12 | 3.25*7 = 22.75 | 1.6*7 = 11.2 |
| 13 | 3.5*7 = 24.5 | 1.7*7 = 11.9 |
| 17 | 2.7*7 = 18.9 | 1.0*7 = 7 |
| 18 | 3.1*7 =21.7 | 1.7*7 = 11.9 |
| 20 | 4.5*7 = 31.5 | 1.7*7 = 11.9 |
| 30 | 3.8*7= 26.6 | 1.9*7 = 13.3 |
| Total 120 | 169.75 | 77 |

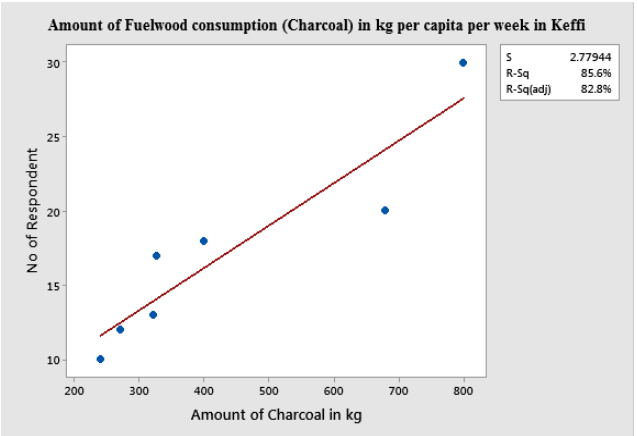


**Figure 5:** The charcoal consumption in Keffi per capita per week

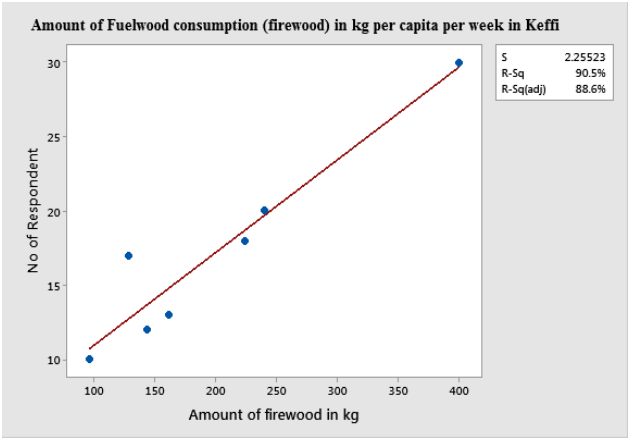


**Figure 6:** Firewood consumption in Keffi per capita per week

Table 3, a total of 727.5kg was obtained from 120 respondents. For the charcoal usage, the per capita per day consumption is 6.06kg multiply by the number of days in a month (30) which is 181.9kg. While, for firewood consumption, the total per capita per day for 120 respondents is 330kg. And the per capita per month of firewood consumption is 2.75kg multiply by the number of days month (30) 82.5kg.

Charcoal = 727÷120 = 6.06kg par capita per day

6.06kg×30 = 181.9kg per capita per month

Firewood = 330kg÷120 = 2.75kg par capita per day

2.75kg×30 = 82.5kg per capita per month

**Table 3:** Amount of fuelwood (firewood and charcoal) per capita per month

| No of Respondent | Amount of Charcoal in kg Total per capita per Month | Amount of firewood in kg Total per capita per Month |
|---|---|---|
| 10 | 3.4*30 = 102 | 1.4*30 = 42 |
| 12 | 3.25*30 = 97.5 | 1.6*30 = 48 |
| 13 | 3.5*30 = 105 | 1.7*30 = 51 |
| 17 | 2.7*30 = 81 | 1.0*30 = 30 |
| 18 | 3.1*30 = 93 | 1.7*30 = 51 |
| 20 | 4.5*30 = 135 | 1.7*30 = 51 |
| 30 | 3.8*30 = 114 | 1.9*30 = 57 |
| Total 120 | 727.5 | 330 |

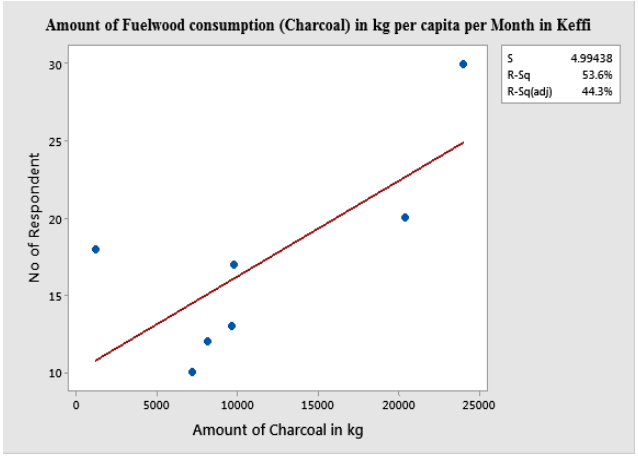


**Figure 7:** Charcoal consumption in Keffi per capita per Month

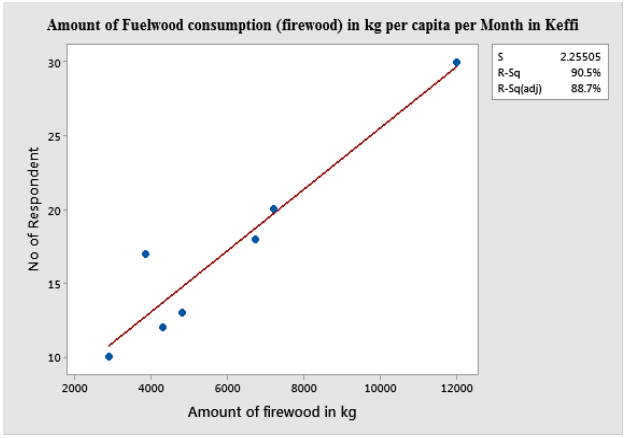


**Figure 8:** Firewood consumption in Keffi per capita per Month

Table 4, the total of 8851.25 was obtained from 120 respondents for the charcoal usage; the per capita per day consumption is 73.8kg multiply by the number of days in an annum (365) which is 26,937kg. While, for firewood consumption, the total per capita per day for 120 respondents is 4015kg. And the per capita per day consumption is 33.45kg multiply by the number of days in a year (365) =12212.3kg.

Charcoal = 8851.25÷120 = 73.8kg par capita per day

73.8kg×360 = 26,937kg per capita per year

Per capita per annum is 26937kg÷120 respondents = 224.4kg

Firewood = 4015kg÷120 = 33.45kg par capita per day

33.45kg×360 = 12,042kg per capita per year

Per capita per annum is 12042kg÷120 respondents = 100.35kg

**Table 4:** Amount of fuelwood (firewood and charcoal) per capita per Annum

| **No of Respondent** | **Amount of Charcoal in kg Total per capita per annum** | **Amount of firewood in kg Total per capita per annum** |
|---|---|---|
| 10 | 3.4*365 = 1241 | 1.4*365 = 511 |
| 12 | 3.25*365 = 1186.25 | 1.6*365 = 584 |
| 13 | 3.5*365 = 1277.5 | 1.7*365 = 620.5 |
| 17 | 2.7*365 = 985.5 | 1.0*365 = 365 |
| 18 | 3.1*365 = 1131.5 | 1.7*365 = 620.5 |
| 20 | 4.5*365 = 1642.5 | 1.7*365 = 620.5 |
| 30 | 3.8*365 = 1387 | 1.9*365 = 693.5 |
| Total 120 | 8851.25 | 4015 |

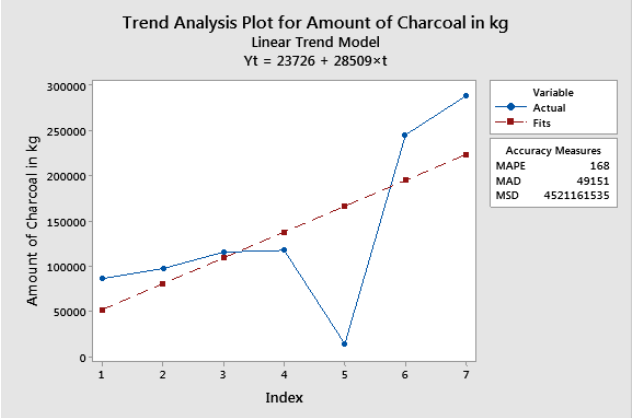


**Figure 7:** Linear Trend Model of Charcoal consumption in Keffi per capita per Annum

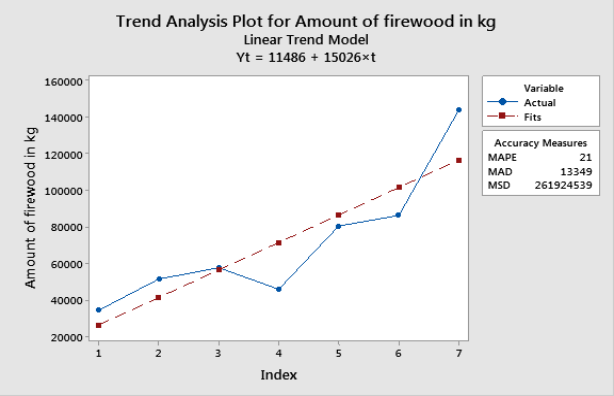


**Figure 9:** Linear Trend Model of Firewood consumption in Keffi per capita per Annum

## 5. Conclusion

Charcoal production technology is very difficult and bad for health (burns, chronic cough) but since this activity is an income source, the adverse health risks are ignored. The negative effect of fuelwood scarcity on household fuelwood and total biomass energy use has important implication for government policies regarding afforestation and sustainable forest management that offers an important option for improving household livelihoods. It suggests that greater access to "clean energy" such as LPG is expected to enhance household welfare and productivity. Also, LPG is very necessary to reduce indoor smoke. Certainly, is recommended the use of LPG for the reduction of pollutants but uses two fossils fuels such as (charcoal + LPG) by households will improve the economic and environmental situation of families. Most of the women engaged in the use of firewood on the daily bases along the roadsides are being suffered from eyes infection and skin irritation. The beans cake sellers, the frayed yam and potatoes are part of the cooking smoke victims. The total per capita per annum charcoal usage in Keffi local government Nasarawa State is 26,937kg by 120 respondents, which means one per is using 224.4kg per annum. While, for the firewood, the per capita per annum is 12,042kg by 120 respondents. Therefore for one person per capita far annum is 100.35kg.

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