Household Energy Consumption Pattern Assessment and New cooking Technologies adoptions in Wolaita Zone, Ethiopia

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Abstract: Household energy consumption regularly constitutes 90% of total energy use in most developing countries through the world. Woody biomass accounts 87% of the total annual biomass energy use globally. It has been estimated numerically that about 2.5 billion people in the developing countries solely depends on a biomass energy sources to meet their household energy demand. Most of rural Africa countries use traditional biomass energy sources for their household cooking and lighting. In 2017 statistics of international energy agency (IEA) data indicates that 45.3% of Africa energy consumption is from biomass and agricultural residues.

The analyses of improved energy saving appliances were conducted and the constraints and opportunity related to household energy sources and use is also performed in the Wolaita zone. In sample survey, sample size determination was an important step in the process of statistical analysis and according to data obtained from Housing Development Section of the Wolaita zone, 110 households were used in the analysis of household energy consumption; which is sufficiently enough according to the sample size calculated above.

This survey study shown that the traditional biomass energy sources were the principal energy source having the highest percentage share (96 %) of sampled households for Injera baking, 96 percent for Wot, 91 percent for tea and 93 percent for coffee. In fact, the contribution of modern energy source is minimal except slightly in the preparation of tea that is by using kerosene stove habitually called as Butagas makes sizeable use as shown in fig.2 above. Further analysis indicated that wood is used as the principal biomass energy source for Injera baking share 93 percent of households, followed by zero percent dry cow dung. A zero percent of the sample households also use electrical energy for Injera baking. It is further indicated that charcoal is also the principal energy source for wot cooking; tea preparation and coffee making and is share 72, 60 and 57 percent of households energy supply respectively. While the pattern for tea reveals that slight difference exist between the traditional biomass and modern energy sources especially with that of kerosene.

Key words: ***Cooking, Energy, Household, Stove***.

I. INTRODUCTION

Household energy consumption regularly constitutes 90% of total energy use in most developing countries through the world [1]. Woody biomass accounts 87% of the total annual biomass energy use globally [2]. It has been estimated numerically that about 2.5 billion people in the developing countries solely depends on a biomass energy sources to meet their household energy demand. Most of rural Africa countries use traditional biomass energy sources for their household cooking and lighting. In 2017 statistics of international energy agency (IEA) data indicates that 45.3% of Africa energy consumption is from biomass and agricultural residues.

Ethiopia has a total energy consumption of around 40,000 GWh, whereof 92 % are consumed by domestic appliances, 4 % by transport sector and 3 % by industry. Most of the energy supply thereby is covered by bioenergy, which in case of domestic use is usually stemming from unsustainable sources. In Ethiopia in 2018 showed that about 83.67% of annual biomass and waste consumption to meet household energy demand especially for cooking and lighting from firewood followed by animal dung (13%) and crop residue (9%), respectively.

Utilization of biomass energy sources for household energy demand may lead to indoor air pollution which further case of illnesses like acute lower respiratory infection (now a days the leading cause of death among children), chronic disease, low birth weights, and higher risk of tuberculosis. Although many sources of indoor air pollution exist by the studies conducted by the World Health Organization have shown that coal and traditional biomass energy sources for heating, lighting and cooking are the most contributors of indoor air pollution in the rural households of developing countries [3]. The WHO estimates that 1.6 million deaths a yearly world wide and 1.4 million illnesses can be attributed to the household burning of such biomass resources [4]. As women are primarily responsible bodies for cooking, and as their children often spend most time with their mothers while they are engaged in cooking activities, thereby women and young children are disproportionately affected. For example, the WHO (2018) estimates that acute respiratory infection is one of the leading causes of child mortality in the world, accounting for up to 20 percent of fatalities among children under five years, almost all of them are in developing countries. In addition to impacts on mortality, indoor air pollution may have long lasting effects on general health and well-being: early exposure to indoor air pollution during childhood may stifle lung development, suggesting that the cost of this pollution may continue later in life. In fact, literatures indicate that environmental insults at early ages can have long lasting influences on human health and productivity.

This study is aims to conduct household energy consumption assessments and the application patterns of improved energy saving and less pollute stoves in Wolaita zone, Ethiopia. Finally, the consequences of household energy consumption of the selected study area of which are the rate indoor air pollution that can case the illness to be recommended. Despite this fact, no published information is available if any systematic study has been conducted to address the inefficient utilization of biomass energy

sources and energy technology quality and safety issue which can have consequently enabled value addition for the consumers and environment such as climate compatible measure development.

1.1 Backgrounds

Like all other regions of Ethiopia, the household energy scene of the Southern region of Ethiopia is dominantly has been using traditional fuels such as firewood, branches-leaves-twigs, charcoal, cow dung, and other agricultural residue and in which household sector is the major consumer of energy. While almost all urban households obtain their cooking energy supplies commercially, the majority of rural households collect 'freely' their fuel wood supplies around their living area. However, with increasing scarcity of these supplies and diminishing of woody biomass resources leads recently to increase in numbers of semi-urban and rural households were observed purchasing traditional fuel supplies. In addition to sem-urban and rural households, thousands of institutions, (hospitals, boarding schools, universities, correctional facilities, etc), commercial food-catering establishments, and cottage industries also depend on traditional fuels for their cooking or other heating energy demands.

Description of the Study area

The study area, Wolaita Zone is located in southern Ethiopia and is bound by geographical coordinates 6.4° and 7.1° N latitudes and 37.4° and 38.2° E longitudes. Its total area is 4,400 km^2 and altitude ranges from 1,200 to 2,950 m above sea level. It is located at a distance of 380 km along the main road that extends north to south from Addis Ababa to Arbaminich town, and is also connected with the South Nation National Regional State capital city, Awassa which is at160 km through Shashemane town to Wolaita road to the south. Hence, first, Boddit, Damot Woide and Dung Fango districts were be selected among 12 rural woredas in Wolaita Zone. This aims at having representation of households with different characteristics in the study. Based on the 2007 Census conducted by the Central Statistical Agency of Ethiopia, the Zone has a total population of 1,527,908, of whom 752,668 were men and 775,240 were women. Wolaita zone is one of densely populated area within the country. According to zonal social- economic profile which indicated in Wolaita zone finance and economic department (2007), average population density for the zone was about 342 persons per square Kilo meter. While 172,514 or 11.49 percent are urban inhabitants, 1,196 or 0.08 percent are pastoralists and the rests are rural agricultural dwellers. A total of 310,454 households counted in this Zone, which results in an average of 4.84 persons to a household, and 297,981 housing units (CSA, 2007).

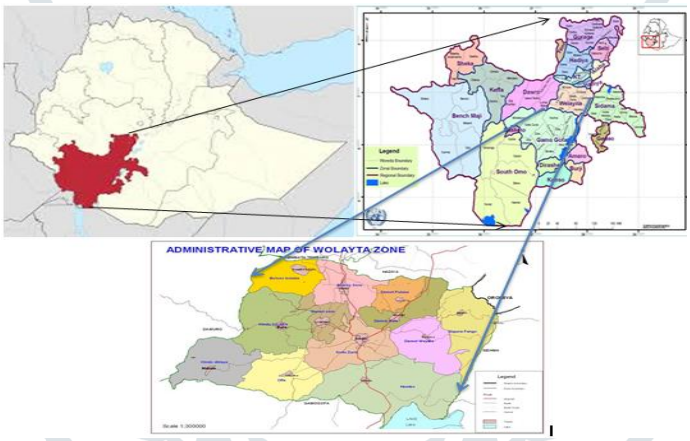


Figure-1: Map of Wolaita zone on the map of Ethiopia

1.2 Objectives of the study

The general objective of the study is to conduct investigation of household energy consumption and improved stoves application pattern in quality and safety of these technologies in Wolaita zone, Ethiopia.
The specific objectives to attain the main objective of the study are detailed as follows; it is:

- ✓ To assess the types of household energy supply in the selected area
- ✓ To asses current status of household energy consumption
- ✓ To assess improved energy saving cooking appliances
- ✓ To generate baseline data
- ✓ To recommend the effects relating with its consequences in rural households relying on traditional fuels based on the investigation result and show alternative opportunities

II. METHODOLOGY

2.1 Study Design

Entirely Randomized Design were used for analysis of consumption pattern of energy sources consumption and the energy quality and safety issues related in its applications of technology benefits samples and field survey analysis were conducted in all selected woredas of Wolaita zone and all experts who are working in this and energy source related sectors and all government employed women and men who have better experience, knowledge, and belief about biomass energy source involved .The analysis of energy source potential of biomass, baseline information for resource efficient traditional biomass energy and climate compatible development. The analyses of improved energy saving appliances were conducted and the constraints and opportunity related to household energy sources and use is also performed in the Wolaita zone.

Sampling procedures and Sample Size Determination

In sample survey, sample size determination was an important step in the process of statistical analysis. To determine sample size of households those to participate in the study, a sampling technique (formula), which was used [5]. In this case population variable (P) was house units' variable, and was given as:

$$n = N Z^2PQ / d^2(N-1)+ Z^2PQ \text{ or } n= Z2PQ / d^2 \quad (1)$$

Where:

- N--Sample size of housing units P= Housing unit variable (residential houses)
- Q--Non-residential houses (eg office, etc.) = 1-P
- N--Total number of household units
- d --Allowable error (0.05)
- Z--Standardized normal variable and its value that corresponds to 95 confidence interval = 1.96

According to data obtained from Housing Construction Development Section of the Wolaita zone (2006), there are about 297,981housing units (N): out of these more than 90% (P) are of residential and the rest 10 % (Q) is for non-residential like commercial activities and offices. Therefore, n is the minimum sample size of housing units for reliable results. To be safe in cases of non-cooperativeness of households, unforeseen problems during collection and other cases the sample size was increased to 138 households. However, due to incomplete participation, incomplete socio-economic data and different reasons some 28 households were reduced from final analysis and thereby therefore, final of 110 households were used as convenient sample size utilized for household energy consumption determination; which is sufficiently enough according to the sample size calculation using above relation. For qualitative part, two experts Agricultural sector, two experts from Water, Mineral and Energy offices of Wolaita Zone, and government employed women and men from the community, a total of 28 households were purposely selected for key informant interview and for an interviewer, respectively. The total number of household was identified through reviewing records in each woreda office of the zone. Then, the total number of households was divided into the required sample size in each kebele proportional to the size of household. Based on this, a sampling interval of every 50th household was visited to get the required number of study subjects in each kebele.

2.2 Data Collection

Both quantitative and qualitative data from primary and secondary sources have been gathered and analyzed. It is accomplished by Household Sample Survey, Focus Group Discussion, Key Informant Interview and secondary data collected reviewing relevant books and journals, published and unpublished documents the researcher.

2.3 Data Processing and Analysis Methods

Data collected through various methods are presented and analyzed using appropriate descriptive and quantitative methods, such as mean, range, percentage, proportion and graphs. In addition to the quantitative data, the household survey data was inputted, processed and analyzed by using the appropriate SPSS software. Relevant statistical methods mainly bivariate correlation and ANOVA test of significance were applied for the validation of the relationships and/or association between the dependent and independent variables.

III. RESULTS AND DISCUSSION

3.1 Types of Kitchen

Since it is the assessment of household energy consumption, first assessment made was the situation of kitchen in the selected areas which is the important variable of the study. The kitchen characteristics in the majority of the households were remarkably similar. As shown in Table 1, below about 69(62.73%) the households of the samples had separate kitchen.

Table 1: Proportion of cooking area or kitchen

	Variables	No. of households	In percentage
1.	In the living room	27	24.54
2.	In the separate private kitchen	69	62.73
3.	In the open field	0	0
4.	In the shared kitchen	14	12.73
	Total	**110**	**100**
n =110,	X^2=2.408	DF = 2 F = 300.573	P = 0.000

More than half of the sample households had separate indoor kitchens outside of the house with one window and without ventilation conditions; otherwise, in 14 (12.73%) of the households, the kitchens were found attached to the living houses. About 27 (24.54%) of the respondents were cooking in their living room. During the interview as well, a 38-year-old woman was asked where she usually cooked, and she replied, "place of cooking is depends on the weather condition. In the winter season, we usually cook in the open field; whereas, in the summer seasons we will be restricted to cook inside of living house which is parts of our residences. While we are cooking with charcoal we usually use our residence as proper place of cooking because it also used for heating too." Hence the problem observed some of the households is lack of knowledge about the selection of prepared place of cooking and the other one is insufficient income to proper suitable kitchen.

3.2 Characteristics of Household Energy Consumption

Principal Energy sources

In Households Out of the surveyed 110 sample households 106(96.36%), 105(95.45%), 100(90.91%), and 102 (92.73%) of the total sample households in their study area were bake Injera and prepared wot, tea and coffee in their home foods.

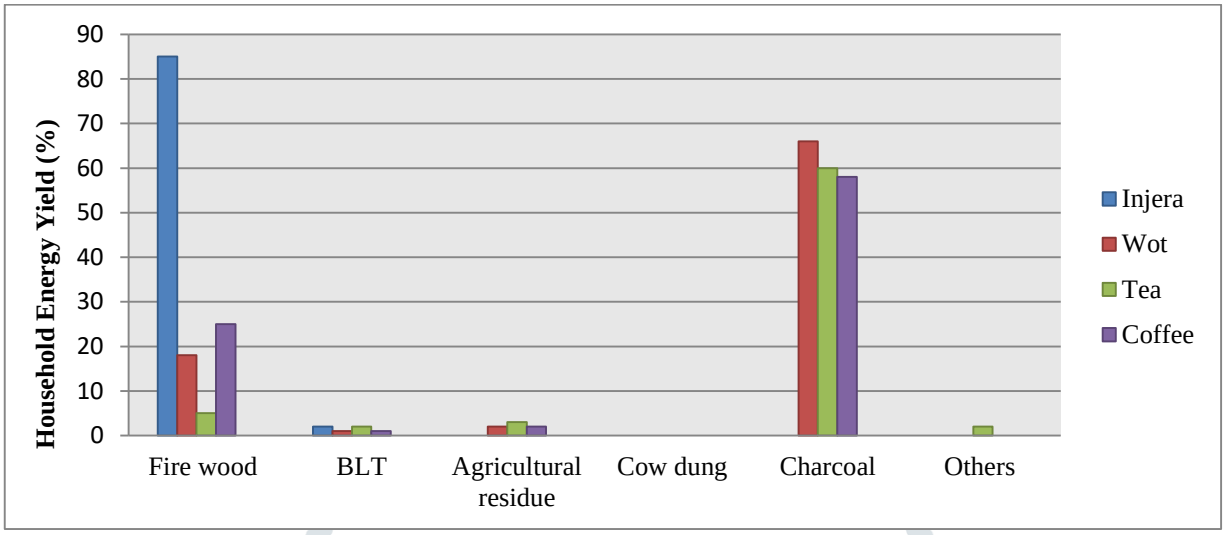


Figure-2: Principal Energy sources percentage of energy supply

This survey study shown that the traditional biomass energy sources were the principal energy source having the highest percentage share (96 %) of sampled households for Injera baking, 96 percent for Wot, 91 percent for tea and 93 percent for coffee. In fact, the contribution of modern energy source is minimal except slightly in the preparation of tea that is by using kerosene stove habitually called as *Butagas* makes sizeable use as shown in fig.2 above. Further analysis indicated that wood is used as the principal biomass energy source for Injera baking share 93 percent of households, followed by zero percent dry cow dung. A zero percent of the sample households also use electrical energy for Injera baking. It is further indicated that charcoal is also the principal energy source for wot cooking; tea preparation and coffee making and is share 72, 60 and 57 percent of households energy supply respectively. While the pattern for tea reveals that slight difference exist between the traditional biomass and modern energy sources especially with that of kerosene. Though, charcoal and wood both constitute 88 percent of sample households' energy demand in tea preparation, the role of kerosene is also highly pronounced in this application. Kerosene in particular plays not significant role as the principal source for tea making. It constitutes about not half the number of households (1.82%) in this sector, sharing almost equal part as charcoal. A comparative analysis of different energy types within traditional biomass energy group also indicated that, biomass energy sources other than wood and charcoal also played important role in the household energy supply. Branch, Leafs and Trunk (BLT) as the principal energy for Injera baking which is used by 3 percent of sampled households while crop residues constitutes1 percent The use of crop residues is less than that of BLT. This may be due to the prevalence of drought in the study area that prevented crop production and lead to the unavailability of farm wastes in general.

3.3 General Technology on Utilization of Biomass Energy Source

Types of Stoves used for Injera Baking

In Wolaita zone, about 49.09 percent of households use open fire three stone Injera baking mud Mitad as shown in Fig.3 below. Others 37.27 percent of the surveys shown in househosds engagement in enclosed traditional Injera Mitad, which have better efficiency in energy saving than open fire normal Mitads. People adopt this oven as a result of better awareness about shortage of firewood and supply, and also as a strategy to save money as firewood cost is being increasing from time to time. In addition to this it can contribute the deforestation problem of the zone. Traditionally people in this area adopted enclosed fireplaces as a strategy to cope with the prevailing energy wood crises in the area (Oxfam GB, 1999).

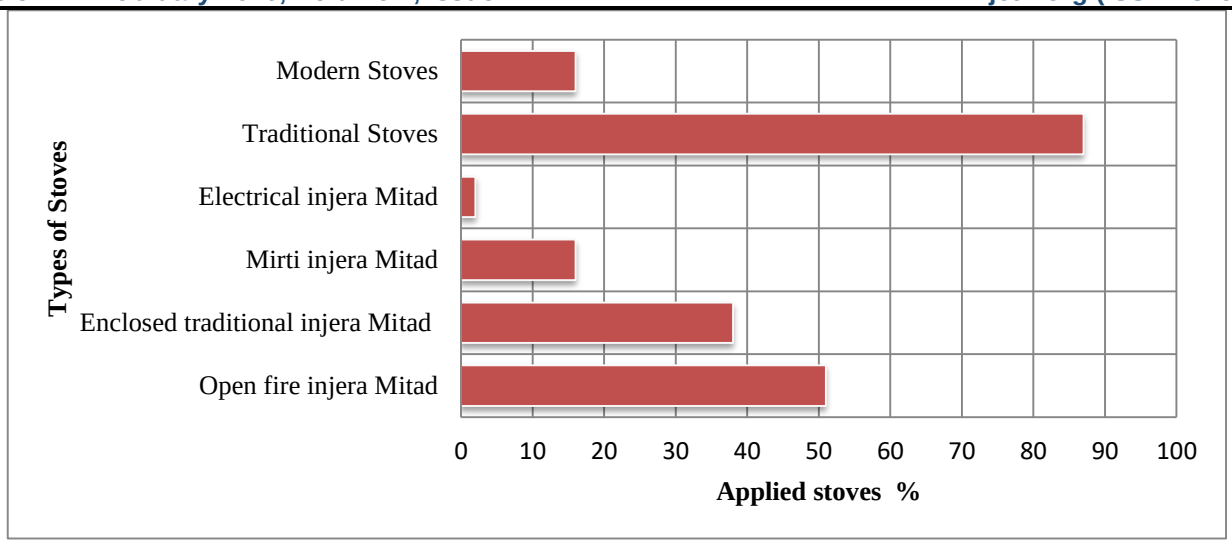


Figure 3: Types of Domestic cooking Appliances and percentage

Despite two decades of effort to encourage and influence people to use the modern and improved cooking stoves for Injera baking by the government as well as NGO'S, the penetration of the modern and improved energy stoves in the Wolaita zone is still insufficient . Mirt Mitad and electric stove users are only 12.72percent and 0.91 percent respectively. Though, the residents of Wolaita are well aware about the benefit of enclosed stove over open fire Mitad, and that they are constrained by several factors from switching over to new model ovens. Due to its fixed nature and spatial inflexibility to use, Mitad requires fixed and proper kitchen place. The survey results show that even enclosed traditional Injera Mitads are mostly used by the households which have their own proper kitchen. In general, therefore, most of the study area households cooking system still stick on to use open fire Injera Mitad. The other problem is the financial limitation of households to purchase Mirt Injera Mitad. The cost of one Mirt Injera Mitad is about 50.00 Birr, the payment for which is to be in cash. This is obviously above the financial capacity of most the specified rural households in Wolaita zone. According to the discussion with two of the three Mirt Injera Mitad producers in Wolaita zone, most of the residents can ill afford to pay the required lump sum of Birr at once. Obviously, in general, households in Wolaita zone still depend more on inefficient open fire and enclosed traditional Injera baking Mitad. This kind of stove cannot trap most of the heat energy, and thereby wastes of energy during combustion burning process will be high.

Types of Stoves Used for Cooking

The pattern for cooking other items of food is quite different. Here varieties of end uses and their peculiar demand for specific energies seem to have imposed on households' burden of acquiring and choosing different types of stoves. Metal charcoal stove, a traditional and inefficient stove, is alone employed by 50.00 percent of households along with 24.55 percent of other types of cooking stoves, the penetration of the modern and improved energy saving and low pollute stoves, is highly pronounced. A kerosene stove, Butagas and Lakech stoves used as cooking appliances are possessed and accounts 7.27 and 17.27 percent of households use either as the only cooking stove or use it in combination with other types of stoves respectively as shown in Fig.4 below.

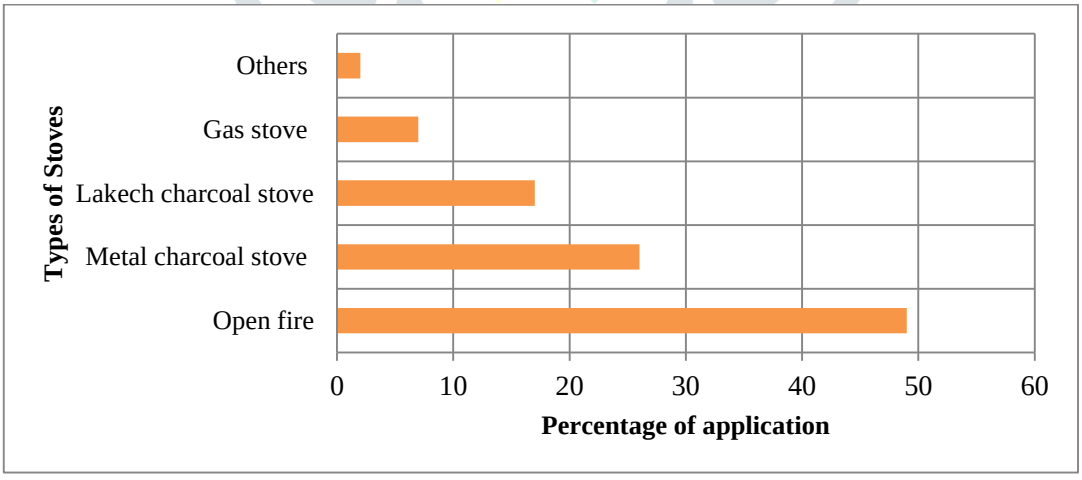


Figure-4: Types of Domestic Appliances and Percentage

One can deduce from the above discussion that, major applications of stoves is accounted by its flexibility in use at any place in or around the dwelling, and also by its relative availability of varieties of stoves in line with the diversified needs of households in the area. Stoves other than baking are available in the market with costs ranging from the minimum 100.00 Birr for Lakech and charcoal stove and each up to the maximum price of Birr 145.00 for Gas stove.

3.4 Household Energy Balance

Total Household Energy Consumption

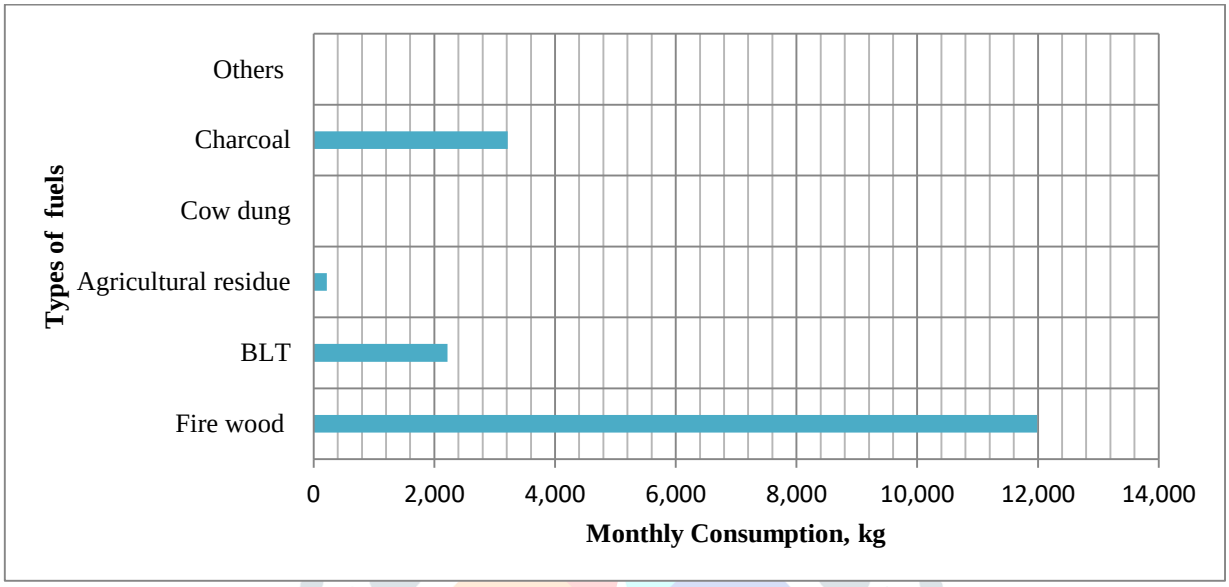
The survey concerning to the total household's energy release determined is 339934.5 MJ of energy per month on average for domestic cooking. Among, biomass energy constitution is about 339685.5 MJ (99.93 %) of this total average per month and the remainder 250 MJ (0.07 %) are constituted by modern energy sources as shown in Table-2 below.

Table-2: Sample Households Monthly Energy utilization in mega-joules

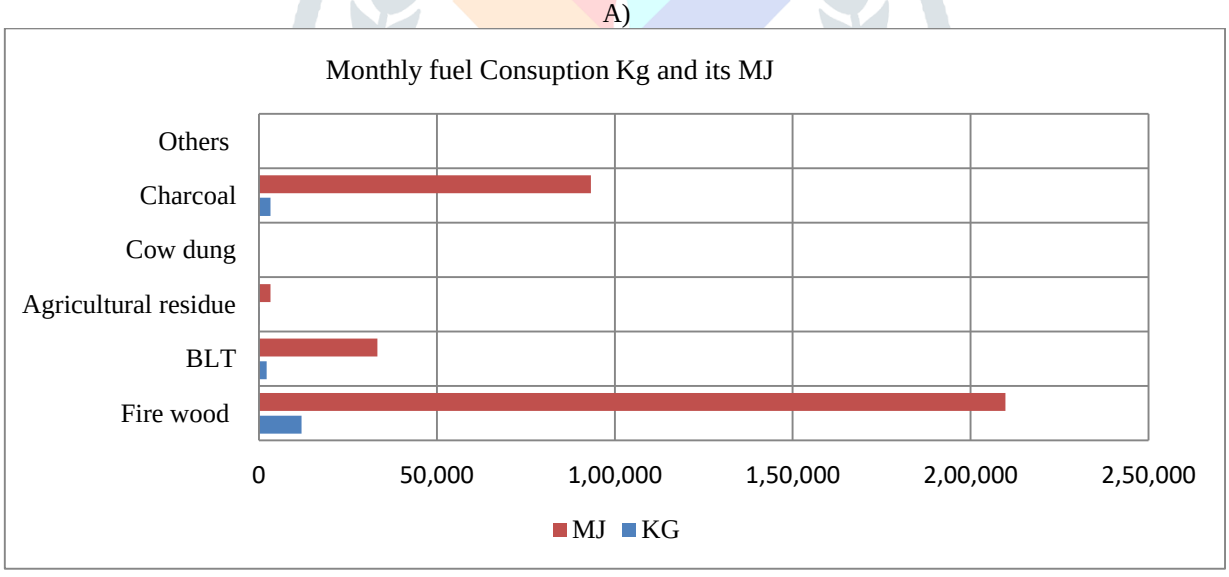
Energy type		Household Energy Consomption			
		Kg	MJ	% total biomass	% of total energy
1.	All traditional biomass energy	17644	339,684.50	100	99.93
2.	Modern energy sources	--	250	100	0.07
Total			**339,934.50**	**100**	**100**

Biomass Energy in the Household Energy Balance

Fire wood types hold naturally the dominant energy source in both its gross weight and energy supply terms. Fire wood constitutes 11989kg (67.95 %) of the total 17644 kg of biomass energy used by sample households in each month on average. In terms of energy content, also firewood is still by far the dominant energy source, contributing 209807.5 MJ (61.72 %) of energy out of the total 339934.5 MJ of biomass energy and 60.68 percent of the total household energy consumed on average per month (Fig.5).



A)



B)

Figure 5: A) Monthly cooking fuel consumption, Kg, B) Monthly cooking fuels energy release in MJ

The comparison of firewood in terms of its weight and energy content indicates that firewood contribute more in its weight than its energy content. This is mainly due to the fact that the calorific value of fire wood is less than that of charcoal, which has more calorific concentrated energy. Charcoal is used as energy source by the majority of the survey area households for domestic cooking, especially for that of coffee and for roasting grains which occasionally accompanied for coffee drinking ceremonial occasions. Charcoal is the most common household energy source next to firewood. According to the survey, it constitutes 3218 kg (18.24 %) of the total 17644 kg of biomass energy utilized by sample households per month as shown in Fig.5 above. Charcoal constitutes 93322 MJ (27.47 %) of energy out of the total 339934.5 MJ of biomass energy and 26.99 percent of the total household energy consumed by the surveyed households. In energy terms, charcoal provides much higher heat than that produced by wood.

Animal dung as domestic energy source contributes about zero kg (0 percent) of the total 17644 kg biomass energy consumed by the surveyed households per month in average. Animal dung contribute zero in energy terms than its gross weight, which factor signifies the inferior quality of dung in the energy content as compared to that of fire wood and charcoal. Dung constitutes zero mega-joules (0 %) out of the total biomass energy and 0 percent of the total household energy consumed per month (Fig.5). Crop

residue is also a much less preferred substitute for wood. It is used generally by the lower income families that can ill afford to pay the increasing price of firewood. In the general household energy balance, however, crop residue constitutes a minimal 219 kg (1.24 %) of the total 17,644 kg of biomass energy. In energy terms also, it constitutes only 3285mega-joules (0.97 %) of the total biomass energy and 0.97 percent of the total household energy consumed each month on average.

BLT also plays significant role in the surveyed household energy demand. It constitutes 2218 kg (12.57 %) and 33270 MJ (9.79 %) of the total 17644 Kg and 339934.5 MJ of biomass energy consumed by the surveyed households each average month respectively. Out of the total household energy it constitutes 9.79 percent.

Cost of Cooking Energy Sources

Findings show that, monthly costs for firewood constitutes the highest share of energy expenditure made for both total and biomass energy. Out of Birr 424 spent for biomass energy per month by the sample households, Birr 275 (64.86 percent) was spent on firewood, which also constitutes the highest share (52.08 percent) of the total costs for household energy per monthly and per year as shown in Fig.6 below.

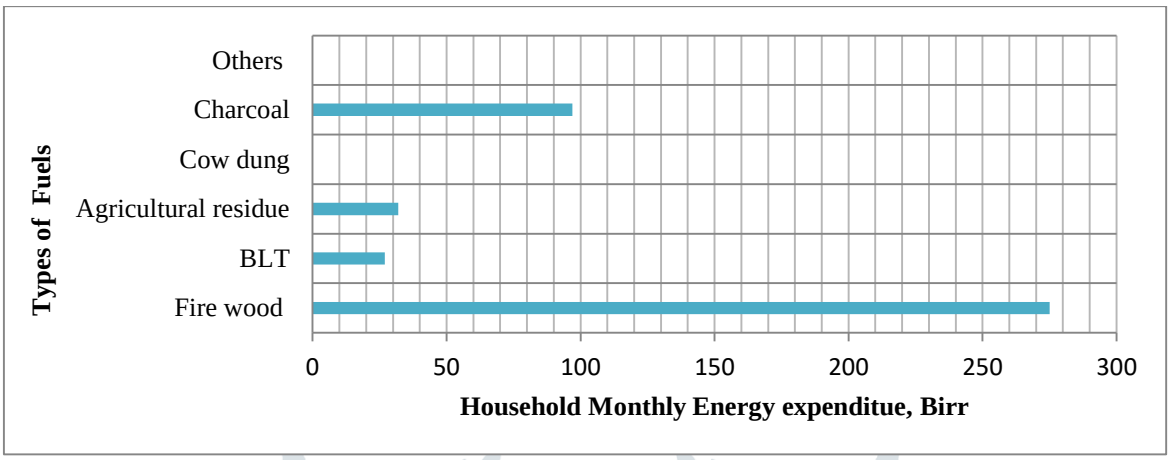


Figure-6: Sample Households Monthly Energy Costs

Owing to the still dominating prevalence of the use of inefficient traditional open fire Injera Mitad in most households, one could deduce this being the driving force for the dominance of wood in the surveyed household energy balance in terms of both its gross weight and costs.

Charcoal is one of the main biomass energies that come entirely from energy market supply. It also constitutes significant part, covering 21.23 and17.05 percent of the total biomass energy and costs made by the sample households per monthly and per year (Fig.6). Thus, it stands only next to firewood in the energy costs balances of the surveyed households. Surveyed households spent Birr 0 per month for dry cow dung for their domestic energy demand entirely for Injera baking. It took 0 and 0percent of biomass energy sources and total energy costs on energy per monthly and per year respectively (Fig.6).

Crop residue is also a lower scale substitute for wood for household energy that could not afford the increasing price of firewood. The monthly cost spent on it is an average of Birr 32 and constitutes 7.54 and 6.10 percent respectively of biomass energy and total costs made for energy per monthly and per year. BLT is one of biomass energy sources in the household energy part of the households under study. The monthly costs spent on it is an average of Birr 27, and constitutes 6.37 and 5.1 percent of biomass energy and the total household energy costs of the sample households per monthly and per year respectively.

Knowledge on Health, Environment and Cost Effects of Biomass Energy

As shown in Fig.7, out of the total households(people) who responded to have knowledge of health effects of biomass energy sources, only 51(46.36 %) are able to name most of the accepted biomass energy utilization related health problems such as cough, irritation of eyes, and breathing related problems. Regarding the respondents' multiple responses about their knowledge of the type of cooking energy sources that cause health problems, 76.36percent of the respondents mentioned smoke from charcoal, 93.4 percent of the respondents said smoke from firewood, 80.91 percent of the respondents said smoke from crop residue, 88.18 percent of the respondents reported that smoke from animal dung and 73.64 percent of the respondents reported that smoke from BLTs disrupt one's health.

Exercise of Biomass Based Renewable Energy Technology and Improved Stoves

The surveyed households exercise disturbed economically and irregular availability of biomass based renewable energy Technology in the study zone. Greater than one-fourth of the sampled households 34(30.91 %) reported the utilization of the existing biomass based renewable energy technology and improved stoves in their village.

The overall dominance of improved biomass based renewable energy technology distribution in terms of the existing and probable demand in the Wolaita zone is far on lower side, indicating an overall dominance of biomass based renewable energy technology scarcity in the Wolaita. This is largely due to the fact that most 76(69.09 %) of the surveyed households still continue to depend upon unimproved biomass energy technology especially on open firewood stove and charcoal stove for their daily routine domestic cooking. It cannot be fully possible to explain clearly, why do they feel and experience lack of distribution at different village of the Wolaita zone, but some senior residents and biomass based renewable energy technology distributers responded that different sets of people required different types of biomass based renewable energy technology, which are all not accessible in all village. This is concerning the fluctuating supplies made in the market, accessibility of biomass based renewable energy technology at the industry, and amount of production accessible for the purpose in relation to the economic development. An expert from the mining and energy bureau is asked about the Improvement of improved biomass energy technologies

efficiency and design of biomass energy saving stoves for environment .According to the expert, both Improvement of improved biomass energy technologies efficiency and design of biomass energy saving stoves for environment and community. "… the potential to reduce the negative impacts of current utilization of biomass energy". "…designed to save heat energy, decrease pollutants, increase combustion efficiency and attain a higher heat energy transfer" "… in savings in the amount of biomass energy source, which translates to direct income savings" "…that accrue from increased utilize of improved biomass energy source technologies include the alleviation of the burden placed on women and children in biomass based renewable energy sources collection, freeing up more time for women to engage in other activities, especially income generating activities" "The provision of more efficient stoves can reduce respiratory health problems associated with smoke emission from biomass energy stoves." " the capacity to improve the efficiency of biomass energy utilize in traditional energy-intensive rural productive activities such as charcoal production, crop drying, wood briquettes and the other related activities" The expert gave the following reasons for this development. "Be produced at low cost and provide a cost-effective solution, environmental protection and improve livelihoods."

" …Under the current control in the traditional and modern biomass energy source parts, the improvements of energy efficiency, in particular increasing end-use efficiency at the household level received major attention by the energy planners and government institutions." An expert from the mining and energy bureau of Zone is asked about the distribution of improved stoves technologies for cooking. According to the expert, about 2862 Lakech and 1328 Mirt stoves have distributed throughout the zone. "…the whole rural and urban households to be about 4190 (14.06%) in Wolaita shift to the improved Lakech and Mirt stoves, a saving of about 1,000,000 ton of firewood which requires clear cutting of forest would been achieved in an annual basis." An expert from the mining and energy bureau is asked about the distribution of improved stoves and modern energy technologies for cooking. According to the expert, both improved stoves and modern technologies have been introduced in some areas of the zone, among which the Mirt firewood stove, the Lakech charcoal stove, the improved 'Gonziye' wood stove, the 'Fetenech' cooking stove and biogas technologies are worth mentioning. Annually on average, about 1,000 improved Lakech and Mirt stoves are distributed in woreda of the wolaita zones.

Accessibility of Biomass Energy Sources With regard to the accessibility of biomass energy sources, almost all, 86 (78percent), of respondents agreed that wood, charcoal, crop residues, animal dung, and leaves are easily accessible, whereas only 24(22percent) of study participants reported that modern energy is easily accessible for cooking.

An expert from the mining and energy bureau is asked about the energy alternatives accessible for cooking. According to the expert, all biomass energy sources are accessible for the community. ". . .though clean energy sources are becoming accessible for the households; firewood and charcoal are the primary means for cooking even in the rural and urban areas of zone." The expert gave the following reasons for this trend.

". . . people of zone has been using charcoal, firewood, BLT and crop residue for hundreds and hundreds of years. It was not what they know and what they were comfortable with to change to modern sources." ". . .still food cooked with charcoal for example is believed to taste delicious than when cooked with other means."

IV. CONCLUSION AND RECOMMENDATION

4.1 Conclusion

Utilization of biomass based renewable energy for traditional cooking among households of Wolaita zone inhabitants was found to be high. The major driving forces for this high utilization were wrong perception about cost of biomass energy sources, insufficient knowledge about the consequences of biomass energy utilization, limited household income, and wrong perception about the accessibility of cooking energy sources. The implications of biomass energy utilization on the community of zone were poor health, ecological imbalance, and cost ineffectiveness. Therefore, understanding the utilization of biomass based renewable energy sources and its implication among households of Wolaita zone is the fundamental element of interventions for climate compatible development, improving the health of the community, maintaining ecological balance, and minimizing cost of living. This possibility may also lead to regeneration of woodlots and biomass energy use and supply. Therefore, based on the findings of the study, the following issues are identified for further consideration to tackle household energy-related problems in areas. In general, households in Wolaita are aware of the benefits of biomass energy saving as reflected in their slowly emerging trend in the use of enclosed traditional and improved stove in some households. Therefore, further promotion activities to use improved stove such as comparative cooking demonstration, like three stone fire versus improved stove as well as joint discussion with the community at places of social, cultural and religious events have to be conducted. Empowering the local improved stove producers by providing loans in the form of revolving fund so as to improve production and marketing. Household energy problems should also be considered in line with other development activities. Like improving the quality of housing and solving housing problem should be taken as one part of solving households' energy problem.

The demand side management of household energy should be given due emphasis and considered as important as the supply side. Different institutions working in the area of afforestation and natural resource protection and conservation should be encouraged to mainstream household energy issues in their development agendas.

4.2 Recommendation

Based on the findings of this study, the following recommendations were forwarded: in order to get our country, Ethiopia, developed clean cooking energies, more efficient biomass energy technologies should be promoted and scaled up by the government as alternatives to biomass energies, government and nongovernment organizations should raise the awareness of the community about the climate, health, cost, and environmental benefits of modern biomass energies, the community should be encouraged to use improved biomass energy technology mix for making energy change, more research is needed to measure the health, economical, and climatic impacts of energy interventions in regions where there is high dependence on biomass energy sources like Wolaita zone.

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