

Assessment of Rural Energy Sources and Energy Consumption Pattern: The Case of Jimma and Ilubabor South-Western Oromia

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Abstract

The study looks in to identifying rural energy sources and energy consumption pattern in the selected representative rural districts and villages of Jimma and also aims at identifying the existing cooking stoves and generates essential information for further interventions in their improvement and promotion activities. The analysis of the result indicates that the study area is characterized by covering almost the whole household energy consumption by fuel wood and very insignificant of free and renewable energy source. Leaving rural inhabitants to continue on the course of the current use pattern of traditional energy sources, will have highly negative consequences for the rural economy at large, as well as the environment and the ecosystem balance Based on results and analysis solutions for curving rural energy related problems with minimum harming effect to the environment were forward in terms of extensive utilization of alternative energy sources, Subsidy provision for improved rural energy technologies that run by renewable energy resources, while importing equipment of rural energy technologies, establishment and expansion of rural energy fund up to local levels in order to create enabling environment to attract private sector, in the development and dissemination of rural energy technologies including improved fuel saving cooking and baking stoves and also strengthening communication and collaborative work between rural energy technology promoting agents.

Keywords: Consumption Pattern; Rural; Energy; Sources

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INTRODUCTION

Access to efficient and modern energy is extremely crucial for the developing nations to counter the economic and health issues and at the same time with the productive use of energy increase the economic growth and life standard of the deprived people. A well performing energy system can provide these people with income generating opportunities as well as to escape them from the awful impacts of poverty. Unfortunately this has not been made possible due to financial issues, lack of resources, effective energy policies and energy systems in the developing nations (Dawit, 2012).

Access to modern and clean energy like electricity and efficient cooking technologies to the rural areas in developing world not only provide improved and healthy life style but would also help in reducing harmful environmental effects. Efforts on the all levels are required to counter this situation with effective projects and policies on government level as well as awareness of the uneducated masses in the rural developing world (FAO, 2010).

Energy is vital to any economic development, to improve societal comfort and wellbeing. Fast economic growth and social transition in western countries are directly attributed to progressive invention and improvement of modern energy services. Currently fossil fuel accounts for more than 90% of overall energy supply of western countries resulting in their share of 80% of the global fossil fuel energy consumption. However, since the mid-20th century, the concern over diminishing reserves of fossil fuel and greenhouse gas emissions arose as new global environmental challenges. The poorest countries in the world were unable to benefit from the cheap fossil fuel era and the associated modern energy services. About 45% of those deprived of modern energy services are living in Sub-Saharan African countries where traditional biomass accounts for more than 90% of their overall energy uses. Biomass is a carbon neutral renewable source based on photosynthesis. Its current use though is associated with burning in inefficient stoves, possibly leading to scarcity of firewood, deforestation and impaired health. Fossil fuel is less likely to provide a solution for poor countries relying on foreign oil imports due to its surging prices and related greenhouse gas emissions Adusei L. A. (2012).

Dependency of the people on traditional energy for catering their cooking and lighting energy demands in the developing nations still prevails especially in rural areas. Poverty, lack of availability of modern energy and lack of education are the main causes of this phenomenon. Abundant use of biomass for meeting the demands also brings the scarcity of these resources like fuel wood.

Another detriment side of utilizing energy in inefficient way is higher consumption of energy than usually required with disastrous health effects due to smoke. Access to modern and clean energy like electricity and efficient cooking technologies to the rural areas in developing world not only provide improved and healthy life style but would also help in reducing harmful environmental effects. Efforts on the all levels are required to counter this situation with effective projects and policies on government level as well as awareness of the

uneducated masses in the rural developing world. The main objective of this study is to assess and analyze the existing energy resources in the area.

METHODOLOGY

Description of the Study Area

This study is conducted in Ilubabor (Gore, Bure and Metu) and Jimma zones (Dedo, Gera and Tiro Afata) in SW Oromia regional state of Ethiopia. Jimma zone is located in the south-west. It is geographically located between $7^{\circ} 45' 00''$ N latitude and $36^{\circ} 47' 00''$ longitude. The minimum and maximum temperature of the zone is 13°C and 25°C , respectively and also the average annual rainfall is 1800mm. Nitosols and Orthic Acrisols are the dominant soil types with slightly acidic PH, which is suitable for coffee and fruit production (ORG, 2003).

Iluu Abba Bora is situated in southwestern part of Oromia Regional State as well as the country. It is bounded by East Wellega and Jimma zones in the east. Iluu Abba Bora also shares a border with West and East Wellega in the North; SNNPR in the south and with Gambella Regional State in the west. It is located between $8^{\circ} 2' 42''$ N and $8^{\circ} 31' 18''$ N and $35^{\circ} 37' 48''$ E and $36^{\circ} 05' 18''$ E

Method of data collection and data sources

In this study the researcher used multiple research approaches from different angles. Based on the nature of enquiry, the researcher applied quasi-quantitative research approach. By applying quantitative principles, the researcher attempted to answer a research question that seeks to describe the existing situations in relation to the patterns and determinants of household energy among selected farmers, specifically, to describe the shortage of energy and how to cope with this shortage of energy. Through qualitative research approach, the researcher collected the opinion of respondents about patterns and determinants of household energy consumption.

The major sources of data include both primary and secondary source at different levels. Primary data was generated through focus group discussion, individual interviews, and formal and informal discussions with farmers, DAs and experts. Focus group discussions, key informant interview and informal discussion were among the employed tools to collect primary data using checklist and semi-structured questionnaire.

Sampling Technique

Survey conducted was using structured questionnaires with individual household interview and focal group discussion methods. Multi-stage sampling techniques were employed for data collection. Specifically the study was conducted in six districts of two zones which were selected randomly at the first stage among 31 districts in Jimma and Ilubabor zones. In the second stage kebele were listed for all selected districts randomly three kebele for each according to their typology. The number of the respondents involved in the study from each kebele was determined in accordance population.

Table1 Distribution of sample households

Zone	Districts	Number of respondent	Percent
Jimma	Dedo	30	16.30
	Gera	26	14.13
	Tiro Afata	35	19.02
Ilubabor	Gore	32	17.39
	Metu	32	17.39
	Bure	29	15.76
Total		184	100

Source: own data

The collected data was analyzed using statistical tools to fulfill the objectives of the study. The quantitative data was analyzed using descriptive statistics like mean, standard deviations frequency and t-test using Statistical Package for Social Sciences (SPSS) for analysis.

RESULT AND DISCUSSION

Households' Input and Utilization of Energy Consumption

This part discusses households' total input energy consumption and the amount of energy effectively utilized. The analysis of the data on patterns of energy consumption can be expressed either in terms of expenditure (ETB) or as the amount of energy consumed in terms of heat value of energy. The amount of energy consumed from each specific energy source can be estimated by converting its expenditure into heat value.

Households' Input Energy Utilization

Biomass fuel, which consists of fuel wood, charcoal, sawdust, dung and crop residues, constitutes the highest share of the total household energy consumption. The most important of all the domestic biomass energy resources is fire wood. Out of the 184 sample households who completed and responded to the questionnaire, almost three

fourth of the participants (75.38%) use fire wood and a minority of participants (24.6%) indicated that they are using the fuel wood different energy sources for household purposes. Fuel wood is, therefore, vital sources of domestic energy in the study area besides the need for construction and household furniture.

With regard to the availability of fire wood, 92.18 percent of sample households obtain it by collecting. Fire wood sellers are both male and female sellers who carry the firewood by their heads and backs, respectively. Households buy mainly of stems from male- sellers and branches from female sellers. 3.82 percent of the households bought firewood from the local market and the remaining percent of the households collect by their own.

The rest 7.82 percent go for buying and collecting. Over half of those surveyed households (57.40%) are able to obtain regular supplies within one km of their residence. The frequency of purchase generally lower among low-income households, they often purchase fire wood less in a year. Location of households has direct impact on the access to collect fuel wood, i.e. the nearer the kebeles to the periphery; the more the fire wood is collected.

Fire wood consumption is often measured in head loads. Enumerators would need to weight a typical head load. Results from questionnaire surveys show that most households in the area consume between five and ten bundles of Fire wood per month. Each bundle of wood fuel ranges in weight from 15 to 30 kg. Although fire wood are usually sold in bundles along the highway with no actual weight measurements, human loads of better quantity of fuel wood are purchased at the outskirts of the town when these vendors are on their way towards the center.

Demographic and Socioeconomic Characteristics of Respondent Households

Demographic characteristics of sampled households, the total sample of the study are composed of different class household categories (model farmers, middle farmers and resource poor farmers). This result is clearly shows that model farmers use improved stove. Discussion with sample respondents revealed that the lower users of improved stove in the study area are mainly due to lack of awareness, shortage of income and access to adequate improved stove in the study area. The result in table also indicated that there is significant difference between the numbers of improved stove user across different villages.

Table 2 demographic and geographic characteristics of the study site woredas (districts) in Jimma and Ilubabor zone

Districts	Population		Total
	Men	Women	
Ale	32,034	32,232	64,266
Dedo	143,935	144,522	288,457
Metu	30,982	30,972	61,954
Gera	56,488	55,907	112,395
Bure	25,312	25,529	50,841
Xiro afata	65,341	66,195	131,536

Age of the household head

Out of the selected 184 sample households, the maximum age observed from the sample respondents was above 45 while the minimum is less than 25 years. However, the majority of the respondents were found to be above 45 years. A vast majority of these households directly or indirectly depend on traditional means of energy.

Sex composition of the household head

Respondent of the study 184 (71 percent) are male (female).

Marital status

About 2 (1.1 percent) people single, while 178 (96.8 percent), 3 (1.6 percent) and 1 (0.5 percent) Married, Divorced and widowed respectively. A large number of households of each group use crop residue, electricity, fire wood, charcoal, cow dung and kerosene as energy source.

Table 3 household head marital status

Marital	Status No of Respondent	Percent
Single	2	1.10
Married	178	96.80
Divorce	3	1.6
Widowed	1	0.5
Total	184	100.00

Table 4 educational background

Level of education	No of Respondent	Percent
illiterate	23	12.5
Can read and write	70	38
Elementary	91	44.5
High school, Diploma	-	-
Total	184	100

Data source: own survey 16/18

About 23 (12.5 percent) of the respondents are found illiterate and 70 (38 percent) could read and write, 91 (44.5 percent) elementary school. Almost 95 of the households have only elementary or below elementary level of education. Due to their educational back ground have no good opportunity to find better job and live a good life. They have no opportunity to afford the high price and shortage of means of energy.

Housing Conditions and Tenure

Regarding housing conditions, the majority of the residential units are poorly constructed and of low standard. This is an indicator to the low living conditions of the sample households. The majority of the housing units (91%) is made of mud, wood and corrugated sheets while only a small share (9%) of the residential units built using hollow blocks or concretes. The major materials used for the construction of wall in the study area are wood and mud (85.2%), stone and cement (10.4%) and hollow blocks (4.4%). It was also observed that most residential units are of standalone types (83.1%) while 16.9 percent of the dwelling units are attached row houses.

Gender Difference in Energy Expenses and Consumption

The minimum and maximum expenditures were 25.66 ETB and 210 ETB for MHHs while they are 37.44 ETB and 347.68 ETB for FHHs, respectively. The mean monthly per capital expenditure ranges from 43.40 ETB for the MHHs to as high as 83.53 ETB for the FHHs. The average monthly expenditure made on energy per household was 86.30ETB for the MHHs and ETB 56.9 for the FHHs. That means MHHs and FHHs are spending 9.64 percent and 15.95 percent of their average incomes, respectively. This shows that FHHs use a higher average income than MHHs for purchasing energy

Table 5 Mean Monthly Income and Fuel Expenditures for Households Headed by Males and Females (ETB)

Gender	Household Income (ETB)			Energy Expense (ETB)			Percentage of income
	Mean	SD	CV	Mean	SD	CV	
MHHs	490.30	148.38	32	86.3	17.4	12.5	9.64
FHHs	171.80	89.50	19	56.90	13.6	8.20	15.95

SD: standard deviation CV: coefficient of variation, MHHs: male household, FHHs: female household

Table 6 Percentage of household consuming a particular energy sources

Districts	Charcoal	Firewood	Crop residue	Kerosene	Cow dung	Solar/ electricity
Gore	19	60	5	9	2	5
Metu	16	54	6	11	1	12
Bure	5	63	23	3	4	2
Dedo	15	65	13	3	-	4
Gera	11	68	9	10	-	2
Tiro Afata	9	59	20	8	-	4
Average	12.50	61.50	12.67	7.33	1.17	4.83

Source: own data

Spatial Patterns of Biomass Energy Consumption

The highest fire wood use occurs Jimma and Ilubabor zone. High amount of fire wood use are found along the highlands and either side of the low lands of both zones. The Jimma and Ilubabor Zones are of Oromia regional state is a renowned coffee producing area located along the south- western. The main charcoal consuming areas are in Gore, Dedo (high land) Gera, Metu (mid highland) and Bure, Xiro Afata in the lowlands. Crop residues are used as fuel almost totally in the highlands although the amounts in Jimma and Ilubabor are relatively low. The main areas of high dung use as fuel are the highlands (Gore and Dedo).

Table 7 Percentage (%) of household consuming a particular energy sources

Districts	Charcoal	Firewood	Crop residue	Kerosene	Cow dung	Solar /electricity
Gore	19	60	5	9	2	5
Metu	16	54	6	11	1	12
Bure	5	63	23	3	4	2
Dedo	15	65	13	3	-	4
Gera	11	68	9	10	-	2
Tiro Afata	9	59	20	8	-	4
Average	12.50	61.50	12.67	7.33	1.17	4.83

The largest percentage of (average) household consuming is firewood in all districts of sampled area. Furthermore, the percentage of household consuming is the highest followed by crop residue, charcoal, kerosene, solar and cow dung.

Useful Household Energy Consumption

Useful energy represents for energy services in the form of effective energy a household obtains.

The amount of useful energy differs from one type of energy to another depend on the quality of energy and how it is efficiently consumed. Energy efficiency is a measure of the energy used in providing a particular energy service end and defined as the ratio of the useable energy output to the energy input.

The households in the village get lesser energy services owing to large dependence on traditional fuels that are used at very low efficiency. The rest parts of village are depend on collecting refuse and by making cow dung to survive the shortage and the high price of energy consumption. However, some of households in the village are dependent on modern fuels for the same amount of expenditure.

The amount of useful energy received per household rises with a rise in household income. This shows that with a rise in a household income, there is a corresponding increase for useful energy and there is a need for household energy and there is a need for households to use more fuels that are used at high. The amount of useful energy received at higher income groups are high mainly due to consumption of better fuels and modern appliances/stoves, mirt and gonze whose efficiency levels are relatively much better.

Baking injera is by far the most important domestic function in many of the households of then village. It dominates the end uses of fire wood, leaves refuse and sawdust. The most important of all types of fuels used for injera baking 152 (82.6 percent) is fire wood. It is used for baking injera among majority of the users. Fire wood and crop residue is the other source of energy used for baking injera among households. The proportion of household using fire wood for baking injera declines with a rise in household income and shortage of fire wood supply. While the proportion of fuel consumers for the same propose increases. The proportion of using fire wood and crop residue for baking injera were 152 (82.6percent) to 15 (8.18 percent) respectively form the whole sampled household.

Table 8 Proportion of households using various types of energy in the domestic function of baking injera

Sources of energy	No of respondent	Percent
Fire wood	152	82.6
Leaves and sawdust	10	5.4
Crop residue	15	8.15
Cow dug	3	1.63
Electricity	2	1.09
Others/ mixed	5	2.72
Total	184	100.00

Data: own survey

Fire wood is used mainly for cooking purposes rather than for baking. Fire wood is the most important energy source, which is used by 146 (79.35percent) households for cooking wot. The remaining proportion was occupied by households, which use charcoal23 (12.5 percent) and kerosene15 (8.15percent). The use of charcoal for cooking purposes was predominance among majority of the high and medium income groups, whereas, fire wood and kerosene use among low and none income group. Fire wood is used mainly for both baking purposes and it is also used for cooking wot in the lower income group wot cooking is frequently cooked almost in all households.

Table 9 Proportion of households using various types of energy in domestic function of cooking wot

Source of energy	No of Respondent	Percentage
Fire wood	146	79.35
Charcoal	23	12.5
Kerosene	15	8.15
Total	184	100.00

Data: own survey

Charcoal and fire wood are used for making coffee. Fire wood is the most important energy source, which is used by 167 (90.76 percent) of sample households for making coffee. The use of charcoal for making coffee was predominance among majority of the high income groups, whereas, fire wood are used among many households in the low income group.

Table 10 Proportion of households using various types of energy in domestic function of cooking coffee

Source of energy	No of Respondent	Percentage
Fire wood	167	90.76
Charcoal	17	9.24
Total	184	100.00

Data: own survey

Table 11 Summary of Households Expenditure Sampled Districts

Districts	Monthly Average Expenditure (in Birr)	Monthly Energy Expenditure (in Birr)	Average Expenditure (in Birr)	Expenditure Share of Energy (%)	Average Household Size
Gore	430	50	10.5	6	
Metu	540	49	9.5	6	
Bure	350	42	8.4	4	
Dedo	290	45	7.3	6	
Gera	260	30	5	4	
Tiro Afata	380	59	12.5	5	
Average	375	45.83	8.87	5	

Data: own survey

Tiro Afata is the leader in terms of average monthly energy expenditure and its share in the overall monthly household budget. The maximum monthly energy cost is Birr 59 whereas the lowest is Br 30 in Gera. Energy expenditure in all districts other than Metu and gore lie between Birr 30 and Birr 49 whereas the figures for Tiro Afata and gore are Birr 59 and Birr 50 respectively.

In terms of expenditure share, Tiro Afata stands out as an outlier with the share being as high as 12.5 percent, closely followed by Gore (10.5 percent). The lowest expenditure share is observed in Gera 5 percent. In conformity with the general prescription that expenditure share of energy decreases with increases in overall income, the largest expenditure share (12.5 percent) was observed in Tiro Afata where the overall average household income.

Energy demand

The main source of cooking energy of rural households in Jimma and Ilubabor zones are biomass Nearly 80 percent of the energy used for lighting in rural of the study area comes from kerosene and 20 percent from solar/electricity. However people prefer to use electricity in the electrified areas but almost 100 percent of the people in rural areas use kerosene for lighting.

To find out the total cooking and energy source and demand were an imperative part of the survey. It was very important for the study and to know the amount of energy utilized by household for cooking and lighting. It was a challenging part to know the correct amount of consumption of a particular type of fuel as most of the people do not pay any attention while cooking about the amount of biomass used. Secondly very few households buy fuel wood or charcoal on a monthly or yearly basis, as most of the people have their own resources or they collect. But as the kerosene is major fuel used for lighting and majority of the households buy kerosene from the market.

Utilization of Cooking Devices and Kitchen Characteristics

The study has particularly stressed on those baking and cooking stoves which are widely in use by rural households. Households were asked if they possess and frequently use the major types of baking and cooking devices. Every household owns different types of stoves. As the survey data shows there are three types of stoves used for Injera baking. About 94.89 percent of households own traditional Injera baking stove(open earthen stove placed on three stones) and the Mirt stove, which burn fuel wood more efficiently, are used by 5.11 percent of households. The study also reveals that about 6.75 percent of households use efficient Lakech stove. Inefficient traditional metal charcoal stoves are also still used by 9.57 percent of the sample households. Simple biogas burners are also used by limited number of rural households (1.58%). It was found that all the sample households own more than one stove and only 11.72 percent of the sample households own all the stated kinds of traditional and modern stoves.

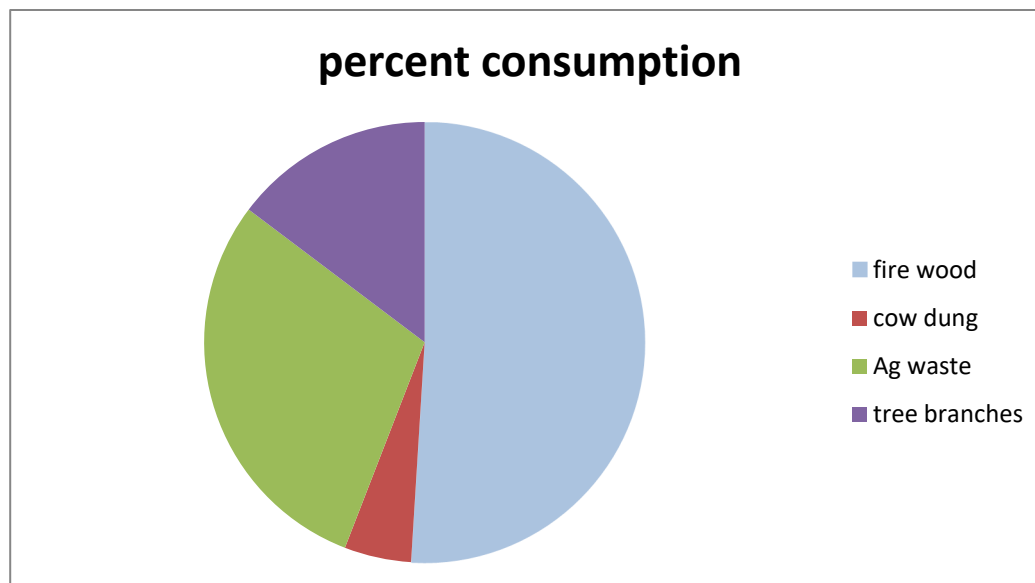


Figure 1 share of biomass in cooking energy consumption

As shown in figure 1, the major share of biomass consumed in the study area as energy is fire wood followed by agricultural waste, tree branches and cow dung. Fire wood constitutes 52 percent of the total biomass in which amount of agricultural waste used for cooking have also been included.

Gender Role and Household Energy Controlling

To know gender roles of energy administration, it is important to know the individual's participation in baking and cooking foods. The study focused on the views of women as they had primary responsibility for cooking within the household. It may have been useful to include male heads as they are often in charge of the household's finances, and hence likely to be influential in household decisions to fund new cooking methods. The results have shown that women have the highest experience to indoor air pollution and suffer from negative health effects especially their eyes since they devote considerable time around cooking fires in a kitchen. Women have all the obligation of baking and cooking activities at home. It shows baking Injera and cooking foods are traditionally a women's job in the area. Females take the lion's share of baking and cooking responsibility. Most actively involved groups in cooking were usually female; Daughters and female servants are usually responsible in preparing, cooking foods and drinks.

Women involved in cooking frequently for making wot (99.23%), baking Injera (100 %) and for cooking local foods (78.90%). Female servants are regularly make cooking to prepare Wot (28.15%), baking Injera (24.35%). Moreover, daughters are also chief cooks to prepare Wot (29.78%), Injera (10.73%) and local foods (10.45%). While, housewives, female heads and daughters are the chief cooks, at the same time, they are also always taken the effort of giving a hand in the main baking and cooking activities. Nearly all of males in rural sampled households are not at all involved in baking and cooking. Despite fact that boy children sometimes take the effort of giving a hand in cooking local foods, women take on the responsibility of cooking. Families believe that male involvement on cooking is not cultural; males occupy most of the time outside home to fulfill the households' demands in all the study area.

Women are basically responsible for meal preparation in the household using traditional fuels. Cooking is not only women's most time and effort-consuming energy need; it is also a very large share of household energy consumption. Since cooking is often conducted in indoor kitchen areas the biomass burning exposes women to high quantities of indoor air pollution which results in poor health conditions for women. Thus, the responsibility for household energy provision affects women's health disproportionately to men's. When communities gain access to energy services, it can have a marked effect on their lives, particularly with respect to release up their time, improving their health and well-being, and opening up opportunities such as enabling them to improve their incomes to improve their living situations.

Usually, amount of energy consumption with traditional cooking systems and the time consumed has been an issue for all concerned. As women were always occupied with household responsibilities including the management of household energy resources, they have very little time for other economic and social activities that could enable them to be empowered socially and economically.

It is a widely held view that managing biomass energy for cooking has a significant impact on women's workload and their health, which have hindered their capabilities and opportunities for participating in economic

and other social activities. Therefore, to minimize the workload of women, the dissemination of efficient, modern and appropriate improved stoves is inevitable.

Conclusions and Recommendations

The study reveals that despite the fact that a majority of sample households used fire wood at home, wood fuels (wood and charcoal) remain to be dominant sources of energy for baking and cooking purposes. Charcoal is most preferred rural cooking fuel and is still very important in the energy mix of all households. The results show that majority of the households regardless of their economic status combine the use of charcoal with other source of energy in their household.

Traditional household energy sources are renewable, but the rate of consumption is much greater than the rate of production. Furthermore, the efficiency of the stoves used to process these sources is very low. Evidently, traditional energy is not sustainable. Traditional energy use increases the rate of deforestation and land degradation, which in turn can lead to excess soil erosion and loss of soil fertility. This further contributes to the decline of agricultural productivity and production, perpetuating the vicious cycle of rural poverty. Indoor air pollution associated with kerosene and traditional fuel use is a major health concern, especially for women and children.

Households in Jimma and Ilubabor zone consume more than half of forest wood in the form of fuel wood and charcoal, as well as many of crop residues. Doing away with traditional fuels, therefore, would save more hectares of forest per annum, help recycle soil nutrients more effectively, and minimize deforestation and land degradation. As such, this triple-win scenario could contribute to an increase in agriculture productivity, helping to break the cycle of rural poverty while also combating global climate change.

The findings revealed a considerable potential for reducing the pressure on local forest resources by substituting or switching from fuel wood to biogas. Awareness within communities will be created and promoted so as to encourage more installations. The participation of people should be ensured for convincing people to adopt biogas technology and encourage local production of biogas installation using local materials for the widespread adoption of the innovation. Dissemination and promotion of bio-gas digesters would be advisable and the private sector should be encouraged to intervene in the field.

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