Impact of Fuelwood Utilization on Forest Resources in Gechi District, South Western Ethiopia

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Dedication

I dedicate this work to my father Niguse Feyisa for his strength and Gentleness.

DECLARATION

I declare that the thesis hereby submitted for the M.Sc degree at the Jimma University, College of Agriculture and Veterinary Medicine is my own work and has not been previously submitted by me or others at another University or institution for any degree. I concede copyright of the thesis in favor of the Jimma University, College of Agriculture and Veterinary Medicine.

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BIOGRAPHICAL SKETCH

Berhanu Niguse was born in Ibantu district, East Wollega Zone of Oromia National Reginal State in September 3, 1985 G.C. He started his elementary school education at Gatama Bese elementary school in 1992 and completed in 2000 and he started his Junior Secondary education at Hinde Junior Secondary School in 2001. He continued his preparatory School at Gida Ayana senior secondary School in 2002, and completed in 2003.Then, He joined Hawassa University, in 2004, and graduated with B.Sc. Degree in Agriculture (plant science) in 2006.

After graduation, He had been working for World Vision Ethiopia since2010 and joined Jimma University, College of Agriculture and Veterinary Medicine, School of Graduate Studies for the Degree of Master of Science in Forest and Nature conservation in 2014.

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List of acronyms

BLT	Branch, Leave and Twigs
CSA	Central Statistics Agency
ETB	Ethiopian Birr
EPA	Environmental Protection Authority
ESA	Ethiopian Statistical Agency
FAO	Food and Agricultural Organization
GHG	Green House Gases
GARDO	Gechi Agricultural and Rural Development Office
REDD	Reduced Emissions From Deforestation And Forest Degradation
REDD+	Reduced Emissions from Deforestation and Forest Degradation and the Conservation, Sustainable Management of Forests, and Enhancement of Forest Carbon Stocks
LPG	Liquid Petroleum Gases
MoA	Ministry of Agriculture
IAP	Indoor Air Pollution
SSA	Sub Saharan Africa
WHO	World Health Organization
PM	Particulate Matter
MoE	Ministry of Education

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Abstract

Fuel wood remains the main energy source for the majority of the people in Ethiopia in general in,Gechi district. It is one of the causes of deforestation in Ethiopia and in Gechi district. Though majority of Gechi district has been covered by forests, the forest cover is generally very sparse in the densely populated areas where rapid rates of forest degradation and depletion have occurred due to the heavy demand on forest products, including fuelwood, and other causes associated with population pressure. This study, was therefore, conducted with the objective of assessing the impact of fuelwood consumption on the forest resource in Gechi district. Data was collected through questioners to know the socio-economic characteristic, causes of deforestation, Sources of energy for cooking and preferences of tree species for fuel wood. The vegetation sampling was conducted in the three agroecological zones to know the average volumes of the tree per hectare on systematically laid plots along transects. In each plots data on tree species, plant height, DBH were collected and volume of tree per hectare in the study area was determine and compare with the household fuelwood consumption. Measurement was conducted by sampling the households to know the volume of fuel wood consumed by people of Chara, Gito and Bido Kebeles and its impact on the forest as well as local community perception towards its impact on the forest resources. The study revealed that 6529.90 tons of fuel wood had been utilized in Chara, Gito and Bido Kebeles per year. It was found that the stand forest at Chara is 10593.75tones on the 125 ha of land. Comparing the stand tree and amount of fuel wood used by the communities of Chara, Gito and Bido is 1.76ha of forest per annum. The most preferred tree species for fuel wood in the area are Syzygium guineense , Maesa lanceolate and Albizia gummiferaThis show that; these species were the most extracted from the forest resources in the study area. The implication of the fuel wood utilization as energy sources for the households in the study area may lead to the forest resources degradation. Use of the efficient energy saving technology, planting fast growing tree for the fuelwood and sustainable use of forest product as fuel wood is recommended .

Key words: deforestation, energy, fuel wood

1. Introduction

Ethiopia has 11.2% or about 12,296,000 ha of forested land and had 511,000 ha of planted forest. Between 1990 and 2010, Ethiopia lost an average of 140,900 ha or 0.93% per year. In total, between 1990 and 2010, Ethiopia lost 18.6% or around 2,818,000 ha of its forest cover (FAO 2010).

The population pressure and agricultural expansion in Ethiopia had increased the forest resources utilization for construction and fuel wood, wood, etc. Hence, different forms of unsustainable forest utilization had been taking place including fires, encroachment, logging, cultivation, urbanization in coming decades ultimately leading to reduce the forest cover. Estimates of the rates of deforestation indicated that 75 per cent of forest losses are attributable to agricultural expansion. It is estimated that over the next 25 years the agriculture sector will require an additional 250 to 300 million hectares of new land to accommodate the demands of commercial farming, subsistence cropping, pasture and range development. Most of this increase in land area will come at the expense of forests lands (Dessie and Kleman, 2007).

Deforestation results in a change in the local ecosystem, loss of biodiversity and increased incidence of drought and flooding. It also leads to a decline in food security due to a reduction of agricultural yields and the loss of valuable forest resources specially loss of soil fertility. Households depend on various kinds of energies for cooking, heating (or cooling) and ironing among other things, broadly categorized as traditional (biomass) fuel which includes firewood, charcoal and stocks; and modern (clean) fuel which includes kerosene, liquefied petroleum gas /LPG/ and electricity (SEI, 2008.)

Consumption of traditional fuels has negative environmental, economic and health impacts. That is, increased use of firewood and charcoal leads to deforestation. It resulted in ecological imbalance and increased use of agricultural residues and animal dung deprives the land essential nutrients that are necessary for soil fertility. Furthermore, smoke from the use of fuelwood and dung for cooking contributes to acute respiratory infections. It causes indoor air pollution, which is worse in poor countries where households' houses are not equipped with separate living and cooking places (WHO, 2006).

Traditional biomass (wood, charcoal, dung) in households accounts for roughly 90% of total primary energy use in Ethiopia (Mekonnen and Kohlin, 2009). About 84% and 99% of urban and rural households, respectively, rely on biomass as their primary cooking fuel (Gurmessa, 2010). Ethiopian households depend overwhelmingly on biomass for cooking in rural areas and even in most urban areas, first, both urban and rural households have upgraded their biomass use, from low-quality residues and dung to wood and charcoal (Damte et al. 2003). In urban areas, a small but growing share of households now use electricity for cooking. At the same time, in urban areas, there has been a shift "down the energy ladder" from kerosene to charcoal or wood, due to rising kerosene prices (Francis and Johnson, 2013). The country biomass fuel consumption / Charcoal, branches, wings and leaves / 105,172,465tones per year from 2000 to 2013 and the charcoal consumption of the country increased from the 48,581 t/year to 4,132,873 t/year (Geissler *et al.*,2013).

1.1. Statement of the problem

Fuelwood shortage, particularly in rural areas of Ethiopia has negative consequence on various socio-economic aspect of the community (Damte et al., 2003). Furthermore, in the absence of sufficient fuelwood, large quantities of crop residue and animal dung are used as fuel, reducing their availability as livestock feed, soil conditioner, and fertilizer. Fuel wood scarcity can increase deforestation, change cooking and eating habits, and promote fuel wood markets.

Meeting the energy needs of growing populations in developing countries is contributing to rampant deforestation, which reduces carbon sinks, contributes to erosion, and results in the overall degeneration of natural systems on which rural communities depend (Damte et al., 2003). In addition to this there is lack of well elaborated studies on the impact of overreliance on biomass based energy on the forest resources in the district area. Fuelwood also serves a source of livelihood for most people and the increasing number of urban dwellers engaged in charcoal and fire wood trade. Increasing scarcity and cost of household fuel particularly fuel wood; increase stressed on women and children who usually supposed to collect fuel wood in the district (GARD, 2015).

The study area is found in the western Oromia which is one of the potential forested area in the country and where most of households are dominantly dependent on the fire wood for cooking

and heating. But there is little evidence on the extent of total households' dependence on fuel wood as energy sources. In addition, there is little evidence on the impact of fuel wood consumption on the forest resources in the study area. Therefore, this study is aimed at understanding the area of forest resource degraded due to fuelwood consumption by households and their impact on the forest resources. In addition, it assesses the attitude and perception of the local community towards forest degradation due to fuel wood consumption.

Therefore, the main reason that necessitated this research are:

- Cutting of trees for fuel wood without replacement has become serious problem contributing to land cover change in the study area; hence it become serious problem causing soil erosion and land degradation.
- Most of energy consumption is from fuel wood that causing significant deforestation
- Inefficient cooking stove and fire wood for cooking cause wastage of a lot of energy and exacerbate deforestation in the study area.
- High consumption rate of fuel wood due to absence of affordable alternative energy sources for people in the study area.

Therefore, it is necessary to assess the impact of the fuel wood consumption on the forest. This study is, therefore, proposed to investigate how fire wood collection and charcoal utilization from the natural forest for use as traditional energy supplies influence the forest resource in Gechi district Illu Ababora, south western Ethiopia.

1.2. Objectives

1.2.1. General objective

The general objective of the study is to assess impacts of fuel wood consumption on the forest resources in the study area.

1.2.2Specific objectives of the study are

- To estimate the volume of biomass fuel wood consumed by the community annually in the study area.

- To identify the community perception on the forest resources degradation due to fuel wood utilization in the study area.
- To identify which tree species/ forest resources are impacted due to the fuel wood collection and utilization by the Gechi district Community.

1.2.3General research questions

Generally, the study seeks to provide answers to the following questions:

- What percentages of the community depend on the fire wood and charcoal for domestic energy consumption?
- Which plant species are impacted by the consumption of the fire wood and charcoal?
- What are the alternative energy sources in the study area to be used by people?
- What are the associated impacts with the increased consumptions of fuel wood in the study area?

1.3 The Scope and Limitation of the Study

The findings of the research work may be used as a base to solve some of the countries environmental problems, if it is conducted widely including all kebeles of the districts. However, due to time, money, and labor constraints, it was too tedious and out of the scope of this research to include all kebeles. Thus, the study was done on three kebeles from the rural area of the Gechi district. The scope of this study was also delimited to the problem related to deforestation practices due to fuel wood consumption. Although treating the overall problem of the environment would enable the inhabitants to aware the impact of environmental degradation on the agricultural productivity, the study was bounded on impact of the fuel wood collection on the forest resources.

2 .Literature review

2.1. Fuel wood consumption and its impact on the forest resources

Deforestation represents one of the most pressing environmental problems faced by almost all Sub-Saharan African nations, and one of the primary causes of deforestation is wood utilization for fuel. Many sub-Saharan countries have had over three quarters of their forest cover depleted.It is estimated that if current trends continue, many areas, especially that of the Sudano-Sahelian belt, will experience a severe shortage of fuelwood by 2025(Mulugeta and Zenebe, 2011). Land clearing by farmers may contribute as much as fuelwood gathering in the depletion of tree stocks. An estimated 20 to 25 percent of annual deforestation is thought to be due to commercial logging. The remaining 15 to 20 percent is attributed to other activities such as cattle ranching, cash crop plantations, and the construction of dams, roads, and mines.

Fuel wood gathering is one of the major contributory factors to deforestation, which is already claiming about 10 Million hectares of forest each year in the developing world (World Bank, 2006). This excessive deforestation has resulted in fuelwood crises in many countries and hence agricultural residue and animal dung are being substituted for fuel wood. But, this reduces the availability of valuable soil nutrients and hence reduces soil fertility, contributing to slowdown in agricultural production (Smil, 1999).

Forest and generally biomass degradation, as well as consequent land degradation, lead to the destruction and erosion of biodiversity of both plants and animals. More specifically, the destruction of habitats, the introduction of a narrow spectrum of crop varieties, recurring droughts, as well as wars and conflicts could be mentioned as the most common causes for the erosion of biodiversity in Ethiopia. In view of the presently growing conflicts between biodiversity conservation and agricultural needs, there is a potential danger that conservation of biodiversity may lose

2.2 Deforestation and forest degradation in Ethiopia

It is important to identify the cause of deforestation and forest degradation (locally, nationally, and internationally). This helps designing mitigation actions that address them, and to assess the impact of these. There are two causes for forest degradation and deforestation. These are direct and indirect causes. The direct causes are human activities or immediate actions that directly

impact forest cover and loss of carbon. The indirect drivers are complex interactions of social, economic, political and cultural factors that aggravate the direct cause of deforestation and forest degradation (MOA and EPA, 2013).

Agriculture is the direct driver for around 80% of deforestation worldwide. In Latin America, commercial agriculture is the main direct driver, responsible for 2/3 of all cut forests, while in Africa and tropical Asia commercial agriculture and subsistence agriculture both account for one third of deforestation (Angelsen and Kaimowitz, 2001). During the last two decades, agricultural expansion, logging, development, and other human activities caused the deforestation of more than 120,000 square kilometers each year. In contrast, an area only one-tenth that size was regained due to reforestation efforts and natural re-growth (FAO, 2000).

Agriculture is the largest global driver of deforestation emissions. Other important drivers of emissions include logging and mining, and all three of these drivers are often spurred by infrastructure development (Morton et al., 2006 and Rudel, 2007). In recent decades, commercial agriculture, supplying urbanizing populations and global commodity markets, has overtaken small-scale agricultural production to become the leading cause of agricultural expansion and of deforestation emissions in the tropics (DeFries et al., 2010; Rudel et al., 2009). Drivers of deforestation differ regionally; in Latin America, cattle ranching, and commercial crops such as soya bean production have been the leading drivers of deforestation (Morton et al., 2006, Macedo et al. 2012); in southeast Asia, expansion of oil palm and other tree plantations is the key driver of deforestation emissions while in Africa, where deforestation rates are considerably lower than in other.

The commercial and subsistence agriculture, mining, infrastructure extension and urban expansion as direct drivers of deforestation; while activities such as logging, uncontrolled fires, livestock grazing in forests, and fuel wood collection and charcoal consumption are considered to be drivers of forest degradation (Hosonuma et al., 2012).

The most prominent driver, with most of its impact focused on forest degradation, is unsustainable fuel wood consumption. Ethiopia's energy consumption is predominately based on

biomass energy sources (94%) (Kebede, 2006). This includes traditional energy sources such as fuel wood, charcoal, branches, leaves and twigs, and current needs largely exceed the level of sustainable production (e.g. from dead wood and plantations), leading to massive degradations of the biomass.

2.3Household fuel wood use and its impact on the Forest resources

Fuel wood is the most common sources of demotic energy for rural community in the world. About the 35% of total population demand on fuel wood for energy sources /cooking and heating/ in the developing countries (Heltberg et.al, 2000). Demand for fuelwood from forest causes forest resources degradation and leads to fuel wood scarcity there are also numbers of consequences which includes Loss of plant species which may cause loss of biodiversity, deforestation, and deterioration of watershed and emission of carbon dioxide into atmosphere (Tadesse, 2007).

If households use clean fuels only occasionally, such as for making tea, and still use traditional biomass for primary cooking, the household IAP level does not change much. A number of studies have examined whether improved stoves reduce IAP and have found that various types of improved cooking stoves have resulted in reductions of toxic pollutants (for example, Ezzati and Kammen, 2002). The actual effect of an improved stove will depend on how the stove is designed and constructed and whether it is used properly. Ventilation conditions also play a significant role in IAP levels. Ventilation conditions can relate to a number of factors, such as kitchen location, housing structure, and cooking practices. There were an estimated 396,000deaths in Sub Saharan Africa due to indoor smoke (WHO, 2006). Every year in developing countries an estimate of 1.6 Million people die from exposure to stove smoke inside their homes; 2.7% of the global burden of disease(WHO, 2006).

2.4 Charcoal utilization trends in Ethiopia

The most significant change that has taken place in the past 15 years has been the massive increase in the consumption of charcoal in all regions. The increase far surpasses the increase in population. (Table 1). In 2000 charcoal was only consumed in significant quantities in Tigray and Somali regions and hardly at all in all the other regions. In the intervening years there has been a massive increase in charcoal consumption by rural households in all regions.

Table 1 Changes in Rural Household Consumption of Charcoal: 2000 – 2013 (tons/yr)

S/N	Region	2000	2013	Difference
1	Afar	1905	214,677	212,772
2	Amhara	-	1,083,524	
3	Benishangul	3,878	34953	31,075
4	Diredawa	-	7,841	-
5	Gambella	32	9,638	9,606
6	Harari	-	8,656	-
7	Oromia	5,031	1,554,763	1,549,732
8	SNNPR	149	448,436	448,287
9	Somali	183,132	498,389	315,257
10	Tigray	19,545	271,996	252,451
Total		48,581	4,132,873	4,084,292

Source: (Susanne.*et.al,*2013).

The reasons for this increase relate to a number of very significant changes that have taken place in the rural socio-economy in the past 15 years. These include:

- Significant increase in rural incomes;
- Proliferation of rural markets;
- Significant reduction in transport costs with improved road system and increase in rural accessibility and
- Land for tree growing reaching limits around cities or areas with growing demand are the most reason for the charcoal demand increase in the country.

2.5. Contribution of forest and forest resources

Forest helps to reduce the impact of climate change by preventing vast amounts of carbon from reaching the atmosphere. It is also important habitats for several other species, plants and animals alike, which help make up earth's biological diversity. This great diversity of trees, plants animals, fungi and micro-organisms, and the complex interactions among them, are what makes forests so valuable to humanity (Ricketts et.al, 2004).

Forest provides wide variety of the wood and non-wood product such as honey, incense, Medicinal plants, bamboos, food staff, Animal fodder and etc. They are socially and economically contribute to significant rural livelihood. The major forest products that can be derived from trees and forests include industrial wood, construction wood (pales and posts), charcoal and fuel wood. The minor forest products cover a wide range of products such as honey and wax from beekeeping, gums and incense, resins, and spices (Heltberg et.al, 2000)).

Forestry Conservation, Development and Utilization Proclamation No.542/2007 of the Federal Democratic Republic Government of Ethiopia defines forest as: "Forest means a community of plants either naturally grown or developed by planting and in many respects are trees and other plants having woody character". Forest resources refers to resources and values associated with forest and range including, timber, water, wildlife, fisheries, recreation, botanical forest products, forage and biological diversity (Stellmacher,2006). According to the same author forest resources refers to extractable resources of biological origin that are derived from the forests and at least potentially have value to the local people. Forest resources may provide forest products and/or services when humans invest time, labor and/or capital input to extract them from forest resources (Stellmacher, 2006). Products are visible and transportable. Whereas, services tend to be less tangible, such as aesthetic and cultural value of forests, its importance as a flora and fauna habitat, and regulation functions.

Fuel wood is the most important forest product in Ethiopia. For example, annual demand for fuel wood (45 million m3) is close to twenty times the demand for other forest products combined. In addition, woody biomass is the country's single largest source of energy supply. The current annual incremental yield of woody biomass resources is estimated to be 14.4 million m3. If harvesting were limited to this volume (sustainable supply) and managed according to prudent practice, some 1.2 million m3 would be used for construction wood, about 0.2 million m3 for industrial wood, and 0.6 million m3 for fodder. This would leave about 12.5 million m3 for fuel wood. The estimated demand for fuel wood of 45 million m3 is almost three and a half times greater than sustainable supply, demonstrating the imbalance between the energy required and the capacity of the forest resources to produce.

Wood fuels (fire wood and charcoal) are the most important energy source and the leading forest product in most developing countries, where they may contribute 50 to 90 percent of all energy used and 60 to 80 percent of total wood consumption. Around 1.8 billion cubic meters of round wood (roughly half of the global supply) is currently used as fuel each year (FAO, 2010).The significance of fuelwood is likely to increase even further due to high fossil fuel prices, persistent poverty, and climate change considerations.

2.6 Household energy Patterns in Ethiopia

The patterns described in the previous section are not without consequence. Unfortunately, despite the widespread understanding of this damage, Ethiopia-specific documentation of this harm is hard to come by; fortunately, the same is not true for the remainder of the developing world, where varied studies on both other African nations and the developing world in general exist, albeit in a randomized manner (i.e., there is no single study, nor a collection of studies, which measures and documents all the negative impacts of energy use for one specific country). Thus, in the absence of in country studies, this section will detail the negative impacts of energy use found from the diverse studies from within Africa and the developing world, referencing Ethiopian studies where possible, and, in their absence, alternative country studies; where the latter occurs, its applicability to Ethiopia will be presented (Kohlin et.al,2001).

Such differences in the way energy use patterns affect different members of the household to varying degrees are not limited to health. As reported by the World Bank (2006), the major task of acquiring sufficient energy in Ethiopia to meet a family's basic needs of food and shelter is delegated to the women, both young and old, of the household, with women's work, more so than men's, depending on access to energy and biomass. Yet acquisition and use is more difficult the greater the reliance of traditional fuels. As exemplified by the World Bank (2006), not only do rural Ethiopian women travel up to 12 kilometers from their home to gather fuels, but they also are forced to collect inferior fuels in the form of bushes, twigs, roots, and crop residues, all of which translate into longer preparation and cooking times; the same is true for urban women, who use biomass for cooking. This shows that forest haven deforested by the households for fuel wood and like fence, fodder, construction and etc.

The more time spent on collection and preparation, the less time spent pursuing more productive activities, such as education; this is unfortunate in a country where, in 2003, only 41.5% of the adult population was literate and only 57.4% of the youth population was literate (UNDP, 2005). With heavy workloads and low-income livelihoods, women also cannot manage without their children, and particularly their daughters. As documented by the (World Bank ,2006) in the Ethiopian town of Jijiga, boys in the Ethiopian village of Delanta reported that `we miss one to two days of school a week in order to work, and girls miss two to three days to help their mothers who are overburdened'. This is attested to by school enrolment rates, as reported by the (UNDP, 2005); just 46% of those eligible are enrolled in primary school, and just 15% of those eligible are enrolled in secondary school. Unfortunately, rapid deforestation, in part caused by fuel wood use, has intensified these impacts. With Ethiopian forests being destroyed at a rate of 200,000 hectares per annum, (Jargstorf, 2004).

Furthermore, as discussed above, poorer households must spend time collecting fuels, which, again, prevents time from being spent in more productive ways that would allow these households to overcome poverty, and thereby mitigate household inequalities. Therefore, it is quite obvious that household energy consumption patterns not only stymie efforts to overcome poverty, but perpetuate inequalities among households.

3. Materials and methods

3.1. Description of the study Area

The study was conducted in Gechi District; Ilu Ababora Zone,Oromia National Regional State. The Woreda capital, Gechi is located at a distance of 140Km from Metu Zonal capital and 460 Km from Addis Ababa on the main road of Jimma- Badele. The altitude of the Woreda ranges from 1500 to 2297 m.a.s.l. It lies within the tropical climate and extends approximately between: 8 0 8'58" North - 80 24' 30" North latitude, and 36017' 30" East - 36031'45" East Longitude. Agro ecology of the district is categorized as dega, woina dega and kola which cover 30.4%, 45.7% and 23.9%respectively (GARDO, 2015).

Figure 1 Map of the study area

An estimated area of the district, based on the former total area of Gechi-Borecha, is about 476 square kilometers. This proportion makes about three percent of the total area of the zone. Gechi is the smallest district of the thirteen districts of Ilu Abba Bora Zone. It shares zonal boundary with Jimma Zone and district boundaries with Beddelle, Borecha and Dedesa districts. It is

generally bound by: Jimma Zone - in the Southwest; Dedesa district - in the South; Borecha district - in the West; and Beddelle district - in the North and in the West.

3.1.1 Administrative sub-division

The district is administratively sub-divided in to one urban and twenty five rural kebeles. There are also Farmers Service Cooperatives (FSCS) that render credit, training, educational, supervision and auditing services. Having preservation for the adequacy of the data, the Gechi District Agricultural Development Office reported that there are 13038 households in the district in 2015. According to the same source the total population of the district in final year 2014 was 75113 (37022 being Male and 38091 Female).

3.1.2 Climate

The district is divided in to three agro-ecological zones: the “Badda” (Dega), "Bede-dere" (Woinadega), and “Gamaji" (the kola) with a proportion of 30.4%, 45.7% and 23.9% respectively. Annual precipitation ranges from 1500-2200mm with 6 to 9 months of rain fall and daily temperature of the district varies from 12 °C to 35°C (LDMA, 2010) .Rainfall variability is important determinants of the life of rural-farming population of Gechi who practice rain fed agriculture. Generally the district experiences tropical climate as a result of its latitudinal location and is modified by altitude (GRADO, 2015).

3.1.3Soil and natural vegetation

According to the information obtained from the Gechi Agricultural and rural development office (GARDO, 2015) the soil distribution of Gechi is dominated by two types of soils: Dystric Nitosols and vertisols. Dystric Nitosols cover the southern and western portions of the district while vertisols occupy the eastern and north central parts of the district.

It had not been for high deforestation rate in past two or three decades, the district was fully endowed with dense, broad-leaved tree forests. This could be deduced from the current presence of remnant indicators of tree species like Aningeria, Podocarpus and etc that are observed standing in the river valleys, farmer's plots etc. The deforestation and de-vegetation processes that are carried out over time seriously resulted in reducing the biomass cover and diversity of the district.

The current combination of natural vegetation of the district includes all types ranging from high dense forests to shrubs and bushes. The species diversity include-*Aningeria* spp, *Podocarpus* spp, *Cordia africana*, *Albizia* species, *Croton macrostachyus*, Bushy trees, *Juniperus procera*, *Sesbania*, *Acacia*, and Savanna grasses e.t.c.

3.2 Selection of the study area and sample size determination

Stratified random sampling technique was used in order to select sample kebeles. There are about 26 kebeles in the woreda. These kebeles were stratified in to three groups on the base of agro-ecological zone. Out of the three strata three kebeles were selected by purposive sampling methods to show representativeness of the agro ecology of the district i.e. Bido Jiren from Woina dega, Gito from Dega and Chara from Kola Kebeles

The number of sample households selected for the questionnaire were determined using the formula developed by Cochran (1977).

$$\frac{NZ^2PQ}{d^2(N-1)+PQZ^2}$$

Where,

n= sample size of household

P = 0.1 (proportion of population to be included in sample i.e. 10%)
q = is 1-P i.e. (0.9)
d = is degree of accuracy desired (0.05)

N= total number of housing units

Z = standardized normal variable and its value that Corresponds to 95% confidence interval equals 1.96. According to data obtained from districts agricultural and rural development office (2015), there are about 13038 household units (N); out of this 1403 households (P) are district inhabitants/who use electric energy either for cooking or for lightening . This is because majority of the district inhabitants use fuel wood for the cooking and baking of' 'injera' and bread even where electric energy source is accessible.

Hence

$$n=\frac{13038(1.96)^2 .08x.92}{(0.08)^2(13038-1)+0.08x0.92(1.96)^2}$$

n=113

These were (42, 33 and 38 from Chara in Kola, Gito in Dega and Bido Jiren in Weyna-Dega agro ecologies respectively) were selected through systematic sampling technique by using the name list of households prepared by kebeles for different purpose i.e. every Nth members were selected from the name lists of the household until the assigned proportion to each kebele was obtained. Therefore, the sample frame of the study is household heads in three sampled kebeles by proportional sampling presented blow (Table 2). While data collection from the interview female households are requested to participate because they are expected to know more about the fuel wood but in their absence during interview male households were participated.

Table 2 Total household heads of the three kebeles and sample size

Kebele	Total households	Sample size	Agro ecology
Chara	489	42	Kolla
Gito	315	33	Dega
Bido jiren	386	38	Wayina Dega
Sum	1190	113	

Sources Gechi Wereda Agricultural and Rural Development Office 2015

The forest inventory plots were established in both in one site Communal forest of free open access and two site of State forest accesses only for fire wood collection The line transect method (Bullock, 1996) was used for inventory of vegetation. A total of six line transects each with an average length of 500 m were laid at a distance of 250 m between transect line at chara forest.

In each plotline transects were determined using a Suunto compass. The first plot is 100 m far distance of from the edges to reduce the edge effect for uniformity of sampled plots. On each

line transect, five sample plots, measuring 20mx20m (400m2), nested plots of 10mx10m (100m2), 2mx2m (4m2), were laid along the transects lines which is approximately at 100m intervals . Total of 30 plots were sampled in Chara forest. Within each four sided sample plot, the number of individual seedlings, saplings, and trees of different species was directly counted. In each plot all woody tree species with a diameter at breast height/ DBH > 5.00 cm and height > 3.00 m were considered as trees and they were measured for DBH and height.. In the study tree species saplings were considered with a DBH < 5 cm and DBH > 2.00 cm, and 0.50 m to 3.00 m height. Similarly seedlings were considered as those stems with DBH < 2.00 cm and height < 0.50 m (Mengistu et al., 2005).

Measurement was conducted to estimate the amount of the households utilized fire wood. To reduce deformed structure of the fire wood that makes difficult for measurements 113 bundles s of the randomly selected collected from the field were cat into smaller piece and laid in straight to avoid gaps between the deformed sticks .The arranged sticks were laid 1mx1mx1m area and compacted. Mean volume of bundles s consumed were calculated to compare with the volume of stand tree annually used for fuel wood.

3.3 Methods of data collection and data sources

The study was undertaken in one communal forest area, and the other two is in Oromia wild life and forest enterprise forest to determine the impact of the fuel wood consumption on the forest resources in Gechi district.

The research utilized both quantitative and qualitative methods to gather data from primary and secondary sources. Primary data was collected directly from respondents using questionnaires (Appendix 1). In addition direct field observation and measurement of required parameters were used for data gathering. Secondary data was collected through review of related literatures and government sector office reports and documents.

At the beginning of the survey, informal meetings were undertaken with a group of farmers in order to understand the general agricultural and socio-economic situation of the population of the study area. Informal meetings with key informants (farmers, elder people, women, experts and

development agents) were held to gain in-depth knowledge about the area and to pre- test the survey questionnaire. Then after, necessary modifications were made to the questionnaire.

In addition to informal contacts, transect walks across each village were conducted in order to obtain all the necessary physical information and determine the questions that need to be included in the survey. It was a useful techniques to characterize and understand biophysical and terrain features such as topography, forest resources, and types of domestic energy use in the local community, land uses, sources of energy for the area.

3.4 Data analysis

The methodologies employed to analyze the collected data is descriptive statistics. With regard to data analysis, responses in the questionnaire and interview and vegetation measurement were entered into SPSS software. Percentage and arithmetic mean were also used in condense the data for the purpose of analysis and interpretation. Furthermore, tables and graphs were used to facilitate results of the analysis and interpretation of data.

Volume of stand tree was calculated to compare the volume of the fuel wood consumed by the households. The stand volume was converted into tones by using the density of tree (Maltamo,.,et al. 2004). This was done by establishing an inventory plot by using Smalian formula of for tree allometric equation (Loetsch et al. 1973) to identify the number of plots , distances between each plots and area of sample plots units for the plantation forest .

$I=\frac{ax100}{A}=\frac{N}{A}$ ..... (1)

$C=\pi r2$ ..... (2)

$V=\pi d^2hf/4$..... .(3)

$D=\frac{\sqrt{Ax100}}{N}$..... (4)

Where

A- Total forest Area

I – Sampling Intensity

N-Number of plots

a-Area of plots

D- Distance between plots

f- Form Factor

V- Volume of stand tree

d-Diameter of tree

h-height of tree

Given I =3-5% more of time use 5%

π= 3.142

f-form factor = 0.45

Based on the formula the following were sampled from the state forest from Gito and Bido Jiren Kebeles' of Gechi and natural forest at Chara Kebele (Table 3)

Table 3 Sample size of the forest in the study area

S/N	Kebele	forest Species	Size forest in ha	Sample plots	Distance between plots in (m)	Area of sampled plots(m^2)
1	Gito	*Cuppressus lusitanica*	6.95	17	6.39	0.02
		Eucalyptus SPP	0.97	2	6.96	0.02
2	Bido	*Cuppressus lusitanica*	12	30	6.32	0.02
3	Chara	Natural forest	125	30	1km	0.04

Vegetation categories were identified, counted and recorded by their local and /or scientific names by using field guide of (Bekele et al., 1993)

4. Results and discussion

4.1Socio- economic and demographic characteristics of the respondents

The result of the study showed that 36.3% of the respondents were male while 63.7% were female. About 50.4 percent of the heads of households were within the age ranges of 25 and 35 years. Nearly 8 percent of the respondents were under the age of 25 years and heads of the households over the age of 45 constituted 3.5 percent of total. The 50.4 % f the respondents are within the age group of 23-35 years; whereas; about 38.1 % belongs to the age group of 35-45 .Thus the results of this study revealed that the majority of the respondents are in the economically active age group (Table 4).

Table 4 Sex and age of the respondent

		Frequency	Percent
Sex	Male	41	36.3
	Female	72	63.7
Age	18-25	9	8.0
	25-35	57	50.4
	35-45	43	38.1
	45-55	4	3.5

From the total participants of this study, 38.1 percent of them have had no formal education of any sort while 18.6 percent of the heads of the households were able to read and write (Fig 2). The remaining 43.5 percent of the heads of households have attended varying level of educational qualification ranging from Elementary school to a high school which is less than the Oromia National Regional State enrolment rate in 2005 which is 61% (MOE, 2005).

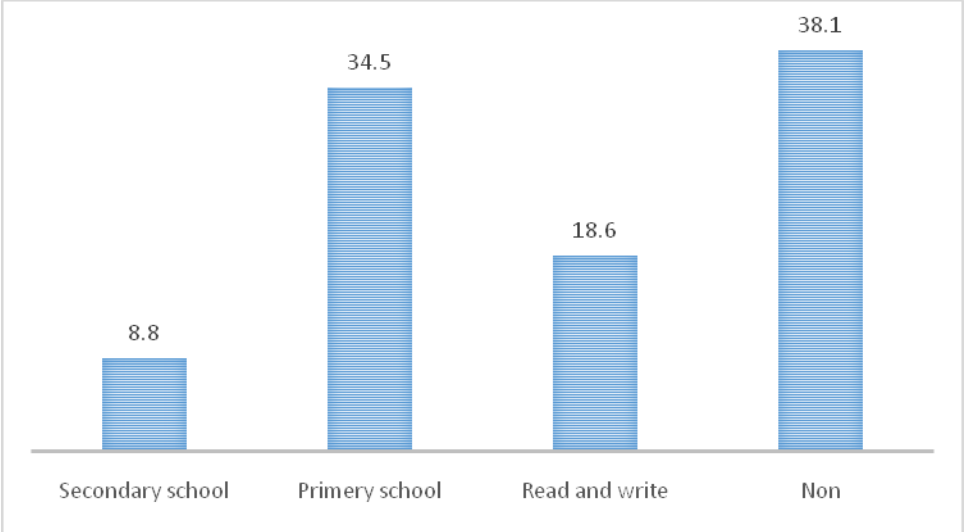

Figure 2 Percentage Educational status of the respondents

About the 92% reported to have fully involved in farming activities as means of supporting their livelihood. The overall average landholding of the respondents in Gechi was reported to be about 1.67 h/HH as described in the (Table 5). This is higher than the total land holding /household 1.1±1.26 and 1.4±1.25 ha in Ada'a and Lume districts of East Shewa, Ethiopia, and higher than the national average of land 1.02 ha (CSA, 2007).

Table 5 Family Size and farm land size in the study area

Item	Minimum	Maximum	Mean±SD
Farm land (ha)	.25	5.00	1.6±0.85
Family size	2.00	11.00	7±2

The mean family size of all the respondents was calculated to be 7.1 persons/ hh (Table 5).The result of this study was higher than the mean family size of 6.2 persons/hh and 6.9 persons/hh

recorded from Bure of Amhara regional state and Dale district of SNNP regional state, both of which are higher than the national average of 5.2 persons/hh (CSA ,2010), the Amhara regional average of 5.4 persons/hh (Halima 2007) and SNNP regional state average of 5.1 persons/hh (CSA, 2007). About 97.3% of the respondents were reported to be Muslim and the remaining 2.7 % were Protestants and orthodox.

The main energy source for cooking in the community is fuel wood for all households having different family sizes. Although all families depend on fuel wood for cooking, families with larger sizes consume more amount of fuel wood (Table 6)

Table 6Community dependence on different energy sources in the study area

Family size		Source of energy for cooking					Total
	No of respondents	Fuel wood	Electricity	LPG	Crop residue	Animal dung	
2.00	1	1	0	0	0	0	1
4.00	2	2	0	0	0	0	2
5.00	15	15	0	0	0	0	15
6.00	22	22	0	0	0	0	22
7.00	34	34	0	0	0	0	34
8.00	17	17	0	0	0	0	17
9.00	14	14	0	0	0	0	14
10.00	2	2	0	0	0	0	2
11.00	6	6	0	0	0	0	6
	113	113	0	0	0	0	113

4.2 Source of energy for cooking and lightening for the community in the study area

The result of the present study revealed that 100% of the respondents use fuel wood for cooking which is higher than the national dependency on the solid energy consumption of the households in Ethiopia which is about 96% in the rural areas (Jargstorf, 2004). About the 85% of farmers in the survey area reported that the distance they have to go for fuel wood collection is increasing through time while only 15% of the respondents indicated that the distance they have to go for fuel wood collection remained the same over time. About 40.71% of the respondents reported that they have been collecting fuel wood from the Communal forest and 27.43% had been collecting fuel wood from state forest. This result indicated that the fuelwood collection has been causing degradation of the forest resources on both the state forest and communal forests.

The reason for using the fuelwood rather than using alternative energy sources as respondent listed; the lack of alternative energy sources, Awareness creation on the alternative energy sources, Smokes from the fuel wood helps in heating their house as well repellant for insect and snake and cost if available are taking the leading reason for the community of the area which accounts 60%. The 90 % of the community are using the three mold traditional cook stove while only 10% are using the efficient cook stove (Table 7). This is one reason that could cause the forest degradation in the area. It is also evident that the local people totally depend on construction materials harvested from the natural vegetation to construct their shelter and for different household utensils and farm implements.

Table 7 Reason for not using alternative energy sources in the study area.

Kebele	Reasons for using fuel wood rather than alternative energy sources					
	No option	No awareness on the issue	Fuel wood used for cooking helps in heating the house	Expensive	Repellent for insect	Total
Chara	27	5	6	1	3	43
Gito	23	3	3	0	4	33
Bido	29	2	2	0	5	38
Total	79	10	11	1	12	113
%	69.91	8.85	9.73	0.88	10.62	

4.3 Fuel wood sources and availability in the study area

The result showed that 40.71% of the sampled households of the Woreda collect fuel wood from the communal forest while 27.43% collect fuel wood from the state forest (Table 8).

Table 8 Sources of fuel wood for the community in the study area

Kebele	From where do you get fuel wood					Total
	Side of road	State forest	Other home stead land	your own land	Communal forest	
Chara	4	0	6	7	25	42
Gito	3	0	3	6	21	33
Bido	3	31	0	4	0	38
Total	10	31	9	17	46	113
%	8.85	27.43	7.96	15.04	40.71	

Most respondents (92 %) believed that the availability of fuel wood in the forest as well on market has been declining in the area (Figure 3). Only 3.5% of the farmers believed that the availability of fuel wood is abundant. This shows that there is degradation of the forest resources in the study area (Fig.3)

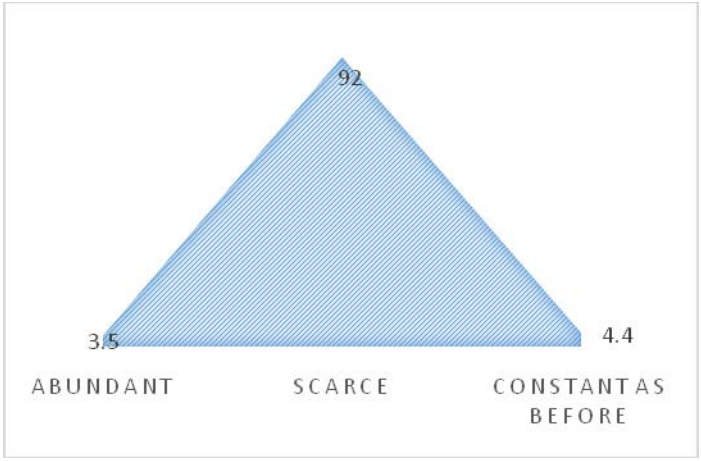

Figure 3 Perception of the community on the availability of fuelwood in the study area.

4.4 Community View on the deforestation in the study area

According to respondents the distance to get fuel wood is increasing. This shows that there is still deforestation in the study due to fuel wood consumption and other activities (Table 9).

Table 9 Community perception on the cause of deforestation.

Cause of deforestation	Frequency	Percent
Agricultural expansion	62	54.9
Fuel wood collection	18	15.9
Cattle grazing	16	14.2
Other(fire,disease,…)	17	15.0
Total	113	100.0

Out of all respondents, 62 (54.9%) of them pointed out that the agricultural expansion is the major reason for deforestation (Table 9) . While 18(15.9%) believe that Fuel wood collection is the second main cause for the deforestation in the study area. The result is similar with the finding of study conducted at Zuway Dugda woreda 75 (41.2%) of the respondents perceived that the lack of more farm land as being the major reason for deforestation (Moges andReddy 2013). In the study area 51.3 % of the community don't plant tree each year (Table 9).In the study area 51.3 % don't plant tree each year (Table 10). This implies that community of the study area have been depending on the natural vegetation for fuel wood, fence construction and etc.

Table 10 Community Tree planting habit in the study area

Did you plant tree each year	Frequency	Percent
YES	55	48.7
NO	58	51.3

4.5 Choice of plant species for fuel wood

The result showed that the most preferred tree species by the Chara is *Syzygium guineense/*Badessa/ while Community of Gito and Bido prefer fuel wood source from the *Maesa*

lanceolata forssk/Abbayii/ (Table 11). It implies that the most preferred species are the most impacted by the fuel wood collection by the Community.

Table 11 Tree species preferred by the community in the study area

S/N	Tree species preferred for fuel wood Mostly	Frequency	Percent
1	*Maesa lanceolata Forssk*/Abayii/	37	32.7
2	*Syzygium guineense*/Badessa/	30	26.5
3	*Albizia gummifera/* Hambabbeessa/	21	18.6
4	*Albizia gummifera*/Ambabessa/	8	7.1
5	*Ficus sycomorus*/Harbu/	5	4.4
6	*Croton macrostachyus* /Bakkanisa/	3	2.7
7	*Eucalyptus camaldulensis*	2	1.8
8	*Cuppressus lusitanica*/Gatira Faranji/	2	1.8
9	*Maytenus arbutifolia*/Kombolch/	2	1.8
10	*Acacia abyssinica*/laaftoo/	1	.9
11	*Celitis africana Burm.f*/qahee/	1	.9
12	*Podocurpus falcatus*/Birbirsa/	1	.9
13	Total	113	100.0

From the Table 11 *Maesa lanceolata* is the most preferred tree species for fuel wood utilization in the study area. The reason for the preference is the availability of the tree species in the study area.

4.6 Wood Density

Stocking averaged 630 trees per hectare of *Cuppressus lucitanica at Bido Jiren; 475 stock/hectare Eucalyptus camaldulensis at* Gito and 647trees per hectares of *Cuppressus lucitanica* at Gito and 1050 different tree/ha at Cara communal forest with *Maesa lanceolata* the dominant species

4.7 Fuel wood consumption of the households in the selected Kebeles

The average amount of fuel wood used by the community in the study area was 6529.9 tones per hectares. Similar result was reported by Mariame, (1996). The annual fuel wood consumption of the community in the study area is presented in the (Table 12).

Table 12 Summary of the household fuel wood consumption in the study area per year household in kg and tones

S/N	Tree species preferred for fuel wood Mostly	Freq	Percent	KG	Tones
1	*Maesa lanceolata* Forssk/Abayii/	37	32.7	1078745	1078.74
2	*Syzygium guineense*/Badessa/	30	26.5	921237.5	921.24
3	*Albizia gummifera*/Ambabessa/	13	11.5	325193.4	325.19
4	*Ficus sycomorus*/Harbu/	11	9.7	204949.5	204.95
5	Croton macrostachyus /Bakkanisa/	9	8.0	201067.8	201.07
6	*Eucalyptus camaldulensis*	4	3.5	147156.5	147.16
7	*Cuppressus lusitanica*/Gatira Faranji/	3	2.7	55636.53	55.64
8	*Maytenus arbutifolia*/Kombolch/	2	1.8	61502.09	61.50
9	*Acacia abyssinica*/laaftoo/	2	1.8	71249.27	71.25
10	*Celitis africana Burm.f*/qahee/	1	0.9	33326	33.33
11	*Podocurpus falcatus*/Birbirsa/	1	0.9	22933.55	22.93
	Sum		100.0	3122997	3123.00
	Average			283908.8	283.91
13	Total	113	100	6529903	6529.90

The study result revealed that three sampled kebele community consume 6529.90 tons of fuel wood of wood which equal to the 1.76 ha of freest per annum for fuel wood only.

4.8 Stand volume of tree in the study area in the state forest

The study reveals that the average volume of the stand plantation forest at Bido Jiren is 508.75m^3 of *Cuppressus lucitanica* and 384.30m^3 of *Cuppressus lucitanica* at Gito and 389.03m^3 of *Eucalyptus camaldulensis* (Table 14). By converting the volume into the tones the stand tones of *Cuppressus lucitanica* at Bido Jiren is 218.68 tones per hectare. This also seves as buffer zone for the forest for fuel wood collection.

Table 13 Stand volume of tree in the study area in the State forest

Area	Species	Plantation year	Age(year)	No. of sample plots	Area(ha)	No of sample trees	No of trees / ha	Mean DBH (cm)	Mean Height (M)	Basal area/ha (m2)	Volume(M3)	
											Per Hectare	Total
Bido	*Cuppressus lucitanica*	1976	31	30	12	387	645	27.5	23.2	124.3	408.75	4905.04
Gito	*Cuppressus lucitanica*	1988	19	17	6.95	222	652.9	27.123	22.5	130.5	384.30	9081
	Eucalyptus camaldulensis	1989	22	2	0.97	19	475	27.79	227	145.3	389.03	377.57

Evans (1992) reported that the mean annual increment of forest in tropics ranges from the 100m3-300m^3 per hectare which is equals to 67-206 tones per hactere. He also argue that the yield may vary based on the tree species, Site quality, spacing, management activities, age, climate etc. The annual fuel wood consumption in the study area is about 6529.9 tones per year. This implies that the fuel wood collection and consumption is one of the main cause for the aggravating deforestation in the study area

4.9Volume of the Chara community forest

The data collected from the vegetation survey revealed that the average volume of the Chara forest is 5.07m^3/.04h which is equal to the 84.75tones per hectares (Table 14). There is 125 ha of communal forest at Chara. The total stand forest at Chara is about 10593.75tones.

Table 14 Volume of stand forest at chara Kebele

Pilot Number	List of tree species	Tree per plot	BA in the pilot	Total Volume in m3	Density kg/m3	KG	Tones
1	*Maesa lanceolata* Forssk/Abayii/	9	0.19	1.22	676	824.72	0.82
2	*Syzygium guineense*/Badessa/	11	0.18	4.4	712	3132.80	3.13
3	*Albizia gummifera*/Ambabessa/	6	0.11	0.71	580	411.80	0.41
4	*Ficus sycomorus*/Harbu/	12	0.36	2.79	432	1205.28	1.21
5	*Maesa lanceolata* Forssk/Abayii/	18	0.33	2.49	676	1683.24	1.68
6	*Syzygium guineense*/Badessa/	19	0.69	5.26	712	3745.12	3.75
7	*Syzygium guineense*/Badessa/	17	0.77	5.87	712	4179.44	4.18
8	*Maytenus arbutifolia*/Kombolch/	39	0.3	2.29	713	1632.77	1.63
9	*Acacia abyssinica*/laaftoo/	24	0.69	5.31	826	4386.06	4.39
10	*Celitis africana Burm.f*/qahee/	45	4.72	35.07	760	26653.20	26.65
11	*Podocurpus falcatus*/Birbirsa/	19	0.72	4.52	523	2363.96	2.36
12	*Maesa lanceolata* Forssk/Abayii/	37	1.33	3.4	676	2298.40	2.30
13	*Syzygium guineense*/Badessa/	30	1.09	6.37	712	4535.44	4.54
14	*Albizia gummifera*/Ambabessa/	35	1.31	9.6	580	5568.00	5.57
15	*Ficus sycomorus*/Harbu/	23	0.69	6.5	432	2808.00	2.81
16	Croton macrostachyus /Bakkanisa/	46	2.06	8	518	4144.00	4.14
17	*Syzygium guineense*/Badessa/	29	1.13	9.85	712	7013.20	7.01
18	*Syzygium guineense*/Badessa/	26	0.92	8.61	712	6130.32	6.13
19	*Maytenus arbutifolia*/Kombolch/	6	0.12	0.89	713	634.57	0.63
20	*Acacia abyssinica*/laaftoo/	6	0.21	1.25	826	1032.50	1.03
21	*Celitis africana Burm.f*/qahee/	8	0.32	2.28	760	1732.80	1.73
22	*Maesa lanceolata* Forssk/Abayii/	8	0.3	1.65	676	1115.40	1.12
23	*Maesa lanceolata* Forssk/Abayii/	15	0.41	3.73	676	2521.48	2.52
24	*Syzygium guineense*/Badessa/	0	0	0	712	0.00	0.00
25	*Albizia gummifera*/Ambabessa/	10	0.38	3.18	580	1844.40	1.84
26	*Ficus sycomorus*/Harbu/	16	0.51	4.79	432	2069.28	2.07
27	Croton macrostachyus /Bakkanisa/	12	0.22	1.13	518	585.34	0.59
28	*Syzygium guineense*/Badessa/	0	0.44	3.07	712	2185.84	2.19
29	*Maesa lanceolata* Forssk/Abayii/	27	0.87	4.68	676	3163.68	3.16
30	*Maytenus arbutifolia*/Kombolch/	16	0.46	3.1	713	2210.30	2.21
	Sum			152.01	19658	101811.34	101.81
	Average per plot	18.97	0.73	5.07	655.2667	3393.71	3.39
	Average per ha	1896.7	72.79	127	16381.67	84842.78	84.75

In general biomass production in the form of removal of wood for fuel has far-reaching negative outcomes; including soil erosion, reduction in the content of soil moisture and decrease in soil nutrients through leaching; for the functioning of the ecosystem (World Bank, 2006). Per the findings in the current study, about 100% of households depend on biomass fuel in the form of firewood for their cooking needs and this definitely is produced by removal of wood cover. The distance to get fuel wood in the study area is increasing from time to time as the data collected from the respondent.

4.10Regeneration of woody Species in Chara Communal forest

From the analysis of seedlings and saplings data, the total population of seedling, sapling and tree was 2750, 2426, and 1615 ha-1 respectively in the chara forest (Fig 4). The distribution of seedlings and saplings is greater than mature tree individuals per hectare. This indicates that the regeneration status of the forest is at high state.

The density values of seedlings and saplings are considered regeneration potential of the species. The presence of good regeneration potential shows stability of the species to the environment. Climatic factors and biotic interferences influence the regeneration of different species in vegetation (Dhaulkhandi *et al*. 2008). Higher seedling density values get reduced to sapling due to biotic disturbances and competition for space and nutrients. The data analysis revealed that the density values for seedlings and saplings of the population structure of the Forest are higher than the matured population. This implies there is good forest management in the study area if the current management practice can be sustained.

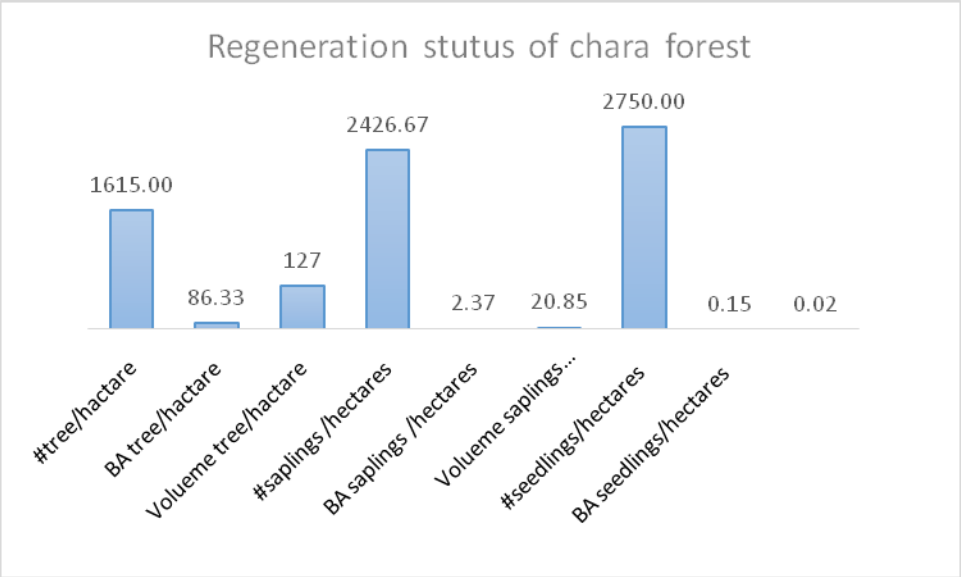

Figure 4 Regeneration status of the Chara Forest

t- tree ha-hectare BA-Basal area S-Saplings SS-Seedlings V-Volume

5. Conclusion and recommendation

5.1 Conclusion

The results of the present study revealed that the negative impacts of fuelwood consumption on forest resources thereby biodiversity and human livelihoods in the study area. The most preferred tree species for the fuelwood Syzygium *guineense/Badessa/ Maesa lanceolata Forssk/Abbayii/ and Albizia gummifera***.** These three species are most extracted from the forest for energy sources for cooking and heating in the study area. Majority of the community in the study area have been using biomass energy sources without tree planting. This is one of the causes for the forest degradation in the study area.

Though fuelwood is a renewable resource, its overuse can lead quickly and easily to shortages especially in the rural communities. As many households continue to use fuelwood, especially in the rural areas of the country like Gechi. This can negatively impact the economy of the households, for example, through deforestation, and declining agricultural productivity. The implications of this on the environment are obvious: deforestation, soil erosion and declining agricultural productivity, and destruction of the ecological system leading to loss in the natural habitat for the wildlife.

5.2 Recommendation

Based on the findings of the research the following recommendations are forwarded:

As wood products harvested from the area is consumed as fuelwood, promotion of fuel saving stoves among rural and nearby town communities would contribute to the sustainability of forest resources.

Firewood use can be made sustainable by the cultivation of fast maturing tree varieties and encouraging local communities to have woodlots. To save Chara forest; plantation forest like at Gito and Bido needs to be practiced. The family woodlots can offer firewood needed and at the same time be a useful in contributing to environmental integrity herby improve soil fertility.

Based on the causes of forest degradation identified by the study, it is recommended that appropriate measures including/planting fast growing tree for the fuelwood, using the efficient cook stove such as Solar energy ,Hydro power and other renewable energy sources / be taken by government agencies, NGOs and development partners to bring to the study . Raising awareness of local communities on the value of forest resources and ecological consequences of deforestation.

Further detailed study of the environmental impacts of the fuel wood consumption on the forest and forest resources in different parts of the country to take corrective measures.

There should be the opportunity for rural electrification for less dependency of natural forests.

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Appendix 1.

JIMMA University College of Agriculture and veterinary medicine

Department of natural resource management
topic: the impact of fuel wood use on the forest resources in Gechi district; south western Ethiopia*NB:* Please mark with X next to the most appropriate answer or write your response in
the spaces provided.

Questioner Code_____Date _____GC

Starting Time_____ Ending Time _____

Respondent resident
place:Wereda_____Kebele_____Zone

1 .Demography

1.1Sex 1.Male 2. Femele

1.2 Marital status

1. Married
2. Single
3. Divorced/Widowed
4. Children only

1.2 Numbers family members_____ Male_____F____Total_____

1.3 Type of house holds

1. Male headed
2. Female Headed
3. Child headed
4. Elderly headed

1.4 Number of people living in the house holds_____

1.5 Highest educational level of head of house hold/spouse

1. University
2. Collage
3. Secondary school
4. Primary school
5. Non

1.6 Religion

1. Muslim
2. Orthodox
3. Protestant

4. Other

2. Socio-Economics of the communities

2.1 Main income generating activities for the House hold leader.

1. Farming
2. Charcoal making
3. merchant
4. Firewood selling

2.2 Household monthly income

a. ≤ 500
b. 500-1500
c. 1500-2500
d. 2500-4500
e. >4500

Natural Capital: Land holding and farming

Do you have land (including ploughed and Gardening?)	1 Yes 2 No
Type of land use	Ha
Farm land	
Grazing/ fallow land	
Perennial crop	
Other specify	
Total	
Do you have coffee farm?	1 Yes 2.No
Size of coffee farm	_____ha

Physical Capital

Do you have the following item in your house holds	1 yes 2. No

Radio	
Television	
Mobile Phone	
Horse/Donkey cart	
Other Specify	

1. Finacial capital : Livestock

Have you owned any livestock during the 12 months /not including kept for relatives/friends or for payment?	
Livestock type	How many Livestock do you today?
Oxen	
Cow	
Young bull	
Heifer	
Calves (less than 1yr)	
Sheep	
Goat	
Donkey	
Horse	
Mule	

2. Sources of energy

2.1 What is the main source of energy for cooking?

1. Firewood exclusively
2. Charcoal exclusively
3. Charcoal and firewood
4. Animal Dung
5. Crop residue
6. Kerosene
7. Liquefied petroleum gas
8. Electricity

9. Other if any _____

2.2 What is the main source of energy for lightening?

1. Fuel wood
2. Crop residue
3. Kerosene
4. Liquefied petroleum gas
5. Electricity
6. solar
7. Other if any _____

2.3 If you use fire wood estimate quantities per day, week, month and yearly. If not used fire wood pass to the next question.

Period	Fuel wood in bundle in KG /Volumes	Unit price	Total price
Per day			
Per week			
Per month			

2.4 If you use Charcoal estimate the value and quantities per day, week, month and yearly. If not used fire wood pass to the next question

Period	Charcoal in KG	Unit price	Total price
Per day			
Per week			
Per month			

3. Means of gaining fuel wood

3.1 How do you gain fuel wood?

1. Buy
2. Collect
3. Other _____

3.2 If your family gained fuel wood by collecting ; distances you go in time to gain the fuel wood estimated

1. Less than 30 minutes
2. 30 minutes to 1hour
3. More than 1 hour

3.3 is the distance go for fuel wood collection increasing or decreasing for the last five years?

1. Yes increasing

2. Remain constant
3. Decreasing

3.4 Where did you get the fuel wood from?

1. Side of the road
2. State Forest
3. Other homestead Land
4. Your own land
5. Other private land
6. Communal forest

3.5 Availability of fire wood and charcoal on the market?

1. Abundant
2. Scarce

3.6 Is the price of fuel wood _____?

1. Increasing
2. Decreasing
3. sometimes increasing and Sometimes decreasing
4. Constant

3.7 What is the reason for you using the fire wood rather than alternative energy sources?

1. Not available
2. Not interested in to use alternative energy sources
3. Not convinced of the advantages
4. Fuel wood used for cooking helps in heating the house
5. Expensive
6. Changes food taste
7. Never thought of such option
8. Wood smoke works as a repellent for insects
9. Wood smoke increases the life of thatched roof

3.8 What type of cook stove do you use?

1. Three mold traditional stove
2. Energy efficient cook stove
3. Electric cook stove
4. Specify other if any_____

3.9. Preference for different energy sources

1. Liquefied Petroleum Gas
2. Kerosene
3. Charcoal
4. Firewood
5. Crop residue
6. Animal dung
7. Electric city
8. Other like solar

4 Impact of fire wood collection o forest resources and socio economic impact

4.1. Did you collect fallen or live tree for fuel wood?

1. YES
2. NO

4.2 Which tree species do you prefer for fuel wood to collect or to buy?

1. All species
2. I prefer the following tree species

   _____he

   space not enough please use the separate bank paper

4.3 Which tree species do you prefer to make charcoal or to buy from market? Please mention

_____

4.4 which forest resources will be impacted by the fuel wood wood collection

1. Wild life
2. Medicinal plant
3. Biodiversity

4.5 What do you think the effects of fuel wood consumption on the forest resources?

1. Deforestation
2. Soil Nutrient Depletion
3. Bush Fires
4. Diminishing Wildlife
5. Climate change
6. Health effect
7. Drought

8. Poverty
9. Complicated

4.6 What do you suggest to improve the impact of the fuel wood collection on the forest resources?

1. Provision of alternative energy sources
2. Awareness creation
3. Rural electrification
4. Forestation
5. Using efficient cook stove
6. Creating Job Opportunity
7. Punishment
8. Subsidizing kerosene

4.7 What will be the benefit if the pressure of the fuel wood extraction reduced on the forest resources?

1. Better water quality
2. Increase Biodiversity
3. Reduced kitchen smoke
4. Better health
5. More forest around the village
6. Better sanitation
7. More grazing area around
8. Better outdoor air
9. Others

4.8 What did you observe the impact of forest reduction on the socio-economic of the people in terms of?

1. Decline of forest product (quality and quantity)
2. Agricultural production
3. Distance to be traveled to collect forest product

4.9 What do you think the reasons for forest degradation in your locality?

1. Natural
2. Human impact

5. Gender and children issue

5.1 Who is responsible for the fuel wood collection in your family?

1. Mother
2. Father
3. Girls

4. Boys
5. Under 18 age Children

a. Is the responsibility of firewood collection is for mother/female children

1 Yes

2,No

5.4 What do you afraid if you go alone for fuel wood collection?

1. Rape/attack /
2. Insects and animals bite
3. Physical damage while collection
4. Not afraid

5.6 How many meals per day do you cook?

1. One per day
2. Two per day
3. Three per day
4. More than four per day

Who is responsible to solve the above problem?

1. Government
2. Community
3. NGO

5.7. What did you suggest for the solution?

1. Rural Electrification
2. Efficient Energy cook stove supply
3. Reforestation
4. Policy making and Implementation

6. Children issue

6.1 IS the fire wood collection is responsibility of children? 1.NO 2.Yes

6.2 If yes when did the child/childern collect the fuel wood

1. After school
2. Early morning before school
3. Weekend time
4. Sometimes left from school

6.4 If yes for the Q 6 .1 How many time did the child/children spend to collect the fuel wood?

1. less 30 Minute

2. 30minute -1hours
3. 1hours-1:1:30 hours
4. 1:30 hours and more

6.5 Do you think that this affect study time of the children/child ?

1. Yes
2. No

6.6 If yes who do you think that solve this problem for for the child ?

1. Family
2. Government
3. NGO
4. Community

6.7 What did you suggest for the solution?

5. Rural Electrification
6. Efficient Energy cook stove supply
7. Reforestation
8. Policy making and Implementation
9. Other if any

Understanding the community perception on the Legislation regulating the use of the woodlands and forests

7.1 Do you know you have complementary roles of communities, private entrepreneurs and the state in forestry development? 1.Yes 2. No

7.1 If Yes Did you plant tree each year ? 1.Yes 2. No

7.2 How many trees did you plant each year?

1. 1-10
2. 10-20
3. 20-30
4. 30 -40
5. 40 and above
5. 7. 3 Do you think that forestry development strategies integrate the development, management and conservation of forest resources with those of land and water resources, energy resources, ecosystems and genetic resources, as well as with crop and livestock production?

1. Yes
2. No

7.4 Do you know afforestation with exotic species be restricted to backyard woodlots, to peri-urban plantations and to plantations for specific industrial and other projects? 1.Yes 2. No

7.5 Do think that the fuel wood consumption have pressure on forest and forest resources ? 1.Yes 2.No

7.6 Did you trained on the forest protection and reforestation or participated meeting on the reforestation and forest protection?

1. Yes
2. No

7.7 If yes who gave you training

1. Government
2. NGO
3. FBO
4. Other
5. CBO

7.8 Did you Participated in reforestation activity in your locality? 1.Yes 2.No

7.9 What are the major causes of Environmental degradation in this area?

1. Deforestation
2. Climate change
3. God's (Allah) wrath against our sins
4. Fuel wood collection

7.10 What are mechanisms used to stop deforestation in the woreda?

1. Reducing tree cutting
2. Penalty and imprisonment

8. QUESTIN FOR THE FFUEL WOOD USER

8.1. Which species is commonly used for fuel wood?

8.2. Why is that species chosen over the rest?

8.3. Do you engaged in local conservation practices to ensure the sustainability of the tree species? (1) Yes (2) No

8.3. If yes, what are the local conservation practices do you use to ensure the sustainability of the tree species?

9 Tree planting

Does your family own wood lot or plant tree in your field/garden?	1 .No 2. Yes
What is the main species in your wood lot?	Mention
What Is the land size /number of tree on your wood lot	_____trees _____ha
1. What is the main use /purpose of our wood lots or planted tree?	2. Selling wood 3. Fuel wood use 4. Construction use 5. Fence 6. Shade 7. Multi-purpose

8. What is the major factor that hindered the house hold from tree planting?	9. Lack of land 10. Lack of tree seedling 11. Lack of fence 12. Other /specify