DRIVERS AND ECONOMIC IMPLICATIONS OF SHIFTING CROP BASED ECONOMY TO CHARCOAL BASED ECONOMY AMONG SMALLHOLDER FARMERS IN AWIE ZONE OF AMHARA REGIONAL STATE, ETHIOPIA

MSC. RENEWABLE ENERGY UTILIZATION AND MANAGEMENT

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NOVEMBER, 2020

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THESIS SUMMITED TO DEPARTEMENT OF ENVIRONMENTAL SCIENCE WONDO GENET COLLEGE OF FORESTRY AND NATURAL RESOURCES SCHOOL OF GRADUATE STUDIES, HAWASSA UNIVERSITY, WONDO GENET, ETHIOPIA

FOR PARTIAL FULFILLMENET OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN RENEWABLE ENERGY UTILIZATION AND MANAGEMENT

NOVEMBER, 2020

ADVISORS' APPROVAL SHEET

SCHOOL OF GRADUATE STUDIES

HAWASSA UNIVERSITY ADVISORS' APPROVAL SHEET (Submission Sheet-1)

This is to certify that the thesis entitled "Drivers and Economic Implications of Shifting Crop Based Economy to Charcoal Based Economy among Smallholder Farmers in Awie Zone of Amhara Regional State, Ethiopia" submitted in partial fulfillment of the requirements for the degree of **Master's** with specialization in **Renewable Energy Utilization and Management,** the Graduate Program of the **Department/School of Environmental Science,** and has been carried out by Yimeslal Tefera, Id. No 018/11, under my/our supervision. Therefore I/we recommend that the student has fulfilled the requirements and hence hereby can submit the thesis to the department.

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ACKNOWLEDGEMENTS

First of all I would like to thank my God, next my Advisors Prof. Samuel Adaramola and Dr. Yosef Melka, for their advice, guidance and valuable suggestions for accomplishment of my thesis work. I also would like to thank my intimate friends from Burie town Alex, Kora, Mengie and special thanks for Dr. Tsebelu Dean of Burie Campus of Markos University and for Fagita Lekoma district Agriculture Office experts who collaborate by providing me information and assist during the field work.

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Abstract

Due to deforestation and other related problems, domestic energy crisis in relation with unsustainable dependency of biomass energy is becoming one of a serious environmental problems in Ethiopia. Therefore, sustainable production of biomass fuels (especially charcoal) is an important for the rural and urban households for own uses and for business opportunities in the rural livelihoods. Hence this study examined the importance of charcoal making in the rural livelihoods and its economic significance comparing with crop production. The study also investigates the drivers of shifting crop based economy to charcoal making house hold economy. Interview questionere was prepared to collect information about the drivers of shifting crop based economic dependency to charcoal producing economy and its economic significance. 205 households gave their response for the questionere from two kebeles (Gendaweha and Gafera) of Fagita Lekoma district, Awie zone, Amhara region. In addition supportive documents, were collected to generalize the economic contribution of charcoal production in the rural livelihoods. The result shows that the gross mean annual income generation per hectare of each farmer from crop production was 10351.22birr and the annual cost of crop production is per hectare was 4000 birr the net annual income generation was 6,351.22 birr. Similarly the gross mean annual income generation per hectare of each farmer from the charcoal production was 27273.17 birr and the cost for annual charcoal production was 12,000birr the net annual income generation of charcoal production was 15,273.17birr. The net mean annual income generation of charcoal production per hectare was 2.4 times the crop production. Additionally, from the total participants of this study more than 95 percent of rural HH responded that productivity loss by erosion is the main driver to shift from crop to charcoal production. Therefore charcoal production is a better business opportunity than the crop production in the study area specifically by its financial return.

Key words: *Agriculture, Biomass fuels, Charcoal, Energy, Sustainable production*

1. Introduction

1.1 Background Information

In developing countries around 2.5 billion people depend on biomass fuels to satisfy the cooking needs and in most of these countries, above 90 percent of total household fuel is derived from biomass (Andriania et al., 2014). The global production of wood charcoal was about 53.2 million tons in 2018, of which 34.2 million tons (or around 64%) were produced in Africa. Due to steady increase in market demand, the production of wood charcoal in Africa almost doubled from 1998 to 2018 (FAO, 2020). Charcoal constitutes primary urban fuel in most of Africa and some developed countries and is a major source of income (Jamala, and G. Y, 2013).

According to the Africa Energy Outlook 2019, a special report of the International Energy Agency (IEA), charcoal will remain an important source of energy in sub-Saharan Africa (SSA) by 2040 with increasing demand for cooking from urban areas (FAO, 2020).

Ethiopia is one of the sub-Saharan Africa (SSA) countries whose energy depends on the traditional use of biomass fuels such as wood, charcoal, agricultural residues and animal dung (Azemeraw Tadesse Mengistu, 2013).

As mentioned in the 2015 IEA energy balance table, Ethiopia depends heavily on biomass for its final energy use. In final energy service sectors, biomass takes more than 90% of the final energy consumption (Yurnaidi and Kim, 2018).

Ethiopian cities are already under pressure from more than 15 million living in urban areas in (2012), and are unable to provide the urban population with access to basic services, including water, sanitation and energy (Cities Alliance, 2017).

Ethiopia is one of the largest charcoal producing countries in the world. Cities and towns burn over three million tons of charcoal each year and charcoal is essentially an urban fuel

across the whole country (Bekele and Girmay, 2014). A charcoal inflow survey conducted in August 2012, into the city of Addis Ababa alone showed an average of over 42,000 sacks, one sack is equivalent to 25 kg which is (1050 tons) of charcoal coming to the city each day and the dependency on charcoal is rather increasing as a result of rapid growth in urban population, and rise in price of modern sources of energy, such as kerosene (Bekele and Girmay, 2014). This all information shows us the demand for charcoal in this country is growing. This will bring that charcoal production is economically feasible and profitable business opportunity. In a number of cases charcoal production has been known as a potential alleviator of financial poverty (Vollmer et al., 2017b).

That is the reason farmers in Awi zone, Fagita Lekoma district have accepted and practiced the development and utilization of acacia decurrens plantation to solve their land productivity and financial problems by producing charcoal. Currently, acacia decurrens is widely spread almost throughout the district of Fagita Lekoma and farmer have proofed that charcoal production from Aacacia decurrens plantation is a solution for their economic problem. Therefore in the study area the farmers' land value has been increased as a result of charcoal production and for income generation. In Fagita Lekoma district charcoal production is solely following traditional carbonization processes, even if the charcoal production is a feasible business opportunity than the agricultural production.

1.2 Statement of the Problem

According to the information gathered from the zone and the district office during field work, the severe reduction of land productivity and land degradation in Awi zone, especially in Fagita lekoma district because of high rainfall and the land topography it resulted in to a complete leaching of soil nutrient making the soil unproductive. Hence farmers often suffered from the failure of crop production. Gulley erosion was also another problem due to the same reason, high rainfall. Hence, during the application of phosphate

fertilizers crops does not utilize the nutrient fixed in the soil, that does not release nutrient to the soil solution and benefit crop production. Thus, farmers suffer from crop failures by getting less reposes from fertilization application. Then farmers were prone to extreme poverty and liable to opportunities of migration to adjacent zones because of extreme land degradation and abandoning the land from crop yield. Therefore, the introduction of *Acacia decurrens* was as a response to this problem and now they have reclaimed the soil nutrient problem and gives a better financial income from the production of charcoal. This practice, planting of *Accacia decurrens* has greatly increased the land value in terms of financial income after some years of hard work. Additionally, planting of *Acacia decurrens* also created more rural jobs across the overall the charcoal value chain.

1.3 Objectives

1.3.1 General objective

The main goal of this study is to compare and evaluate the net annual income contribution of charcoal production with crop production and to know the drivers of livelihood changes.

1.3.2 Specific objectives

- To identify major drivers of crop based economy to charcoal based economy.
- To compare the financial income generation of charcoal production with crop production.

1.4 Research questions

- What is the cause of shifting crop based house hold economy to charcoal producing household economy?
- How much is the average financial income of charcoal and crop production per hectare per year in ETB?
- How much is the average financial cost for charcoal and crop production per hectare per year in ETB?

1.4 Significance of the study

Agriculture in Ethiopia is the main contributor in the country GDP almost 41.4% of and 80% employment opportunity creator (Matouse, Todob & Mojoc, 2013) but, recently from climate change, low input and loss of land productive are the main challenge in the country agriculture sector. In some part of the country due to this factor there is land use change to more profitable land use form like by growing fast plantation tree for charcoal production in some part of the country like Awi zone in Amhara region. In this regard the study has significant contribution in enlightening the economic contribution this charcoal production system by using fast growing tree species like *Acacia decurrens* than to crop production system. Additionally by undertaking cost benefit analysis it reveal the profitable of charcoal production and it provide another option of land use for the place which have high rate land degradation and low productive in crop production which result low economical return. And also the study provides alternative option for the energy problem of the area and provides some recommendation in order to minimize the environmental impact that caused from charcoal production and to enhance of the contribution of climate change mitigation. Additionally study will be as one source of information for the scientific community and decision-makers regarded to land use change related charcoal production. And finally the research serve as the getaway for further research to land use change in the study area specially the change from crop production to charcoal by using fast growing tree species like *Acacia decurrens*.

2. LITERATURE REVIEW

2.1 Charcoal production and utilization

Charcoal has been found to be a major forest product whose role as a source of rural dwellers' livelihood has not been fully examined and used in rural and urban areas to meet the various energy needs, by providing a reliable, convenient and accessible source of energy at a relatively stable cost in a required proportions (Po, 2018).

According to John and Martijn, (2010), the charcoal production process may take up to a few weeks, during the production process around half of the energy in the fuelwood is usually lost (but the charcoal produced has greater energy content per unit mass). When the process has finished, the resulting charcoal look like smaller, lighter pieces of darkened wood, these will have higher energy content by weight than fuelwood (John and, Martijn, 2010).

Compared to burning wood directly as a fuel, charcoal has obvious advantages, due to the removal of moisture and volatile matters from wood, charcoal fires can generate high temperature and last longer with little smoke (FAO, 2020). Furthermore, it is relatively easier and less costly to transport charcoal than wood, particularly over long distance (FAO, 2020). These comparative advantages combined with its availability, affordability, and reliability in local markets makes charcoal an important popular cooking fuel in many countries, particularly in areas without reliable access to modern energy services (FAO, 2020).

The desirable properties of quality charcoal are: lower moisture content (between 5 and 10%), slow burning with higher calorific value (from 27 to 33 MJ/kg), and higher fixed carbon content (from as low as 50% to as high as 95%), lower ash content (between 0.5 and 5%), and producing little smoke without objectionable nor toxic fumes and neither

spits nor sparks. These qualities are found in many Acacia species and some other woody species (Bekele, and Mel, 2014).

2.2 Traditional charcoal production

In Ethiopia, charcoal is commonly produced using the traditional earth kiln method–earth mound kiln and earth pit kiln; earth mound kiln being the most frequent method with an efficiency of 10-15%. All evidence indicates that the prevailing charcoal production systems in Ethiopia are unsustainable because the production technology (earth kiln) is highly inefficient (Bekele and Girmay, 2014).

Charcoal has been an important domestic product for many years and has wide market acceptance (Jamala, and G. Y, 2013). Charcoal made from wood has been in use as energy source since ancient times and is still widely used nowadays in many countries (FAO, 2020). But traditional kiln has three key advantages that need to be taken into account when proposing alternative solutions (Neuberger and Wanjira, 2015).

1. Zero-Cost: Requires no capital investment or special tools to build.
2. Portability: Can be built on an open piece of land near woodlots. This allows minimum effort from charcoal producers for transportation of wood for carbonization.
3. Operation: Requires no specialized technical knowledge or equipment to operate and minimum oversight.

One of the major challenges facing sustainable charcoal production is the use of traditional inefficient kilns (carbonization techniques which is burning biomass under controlled oxygen) that yield 10-20% charcoal in weight of original wood which implies that 100kg of wood produce 10-20kg of charcoal resulting into wood wastage and large areas of land required to produce charcoal (Anang et al., 2011).

2.3 Improved charcoal production

According to (Neuberger and Wanjira, 2015), there are three different types of kilns included earth kilns, brick and metal kilns

Improved Earth Kiln

The improved earth kiln offers better Carbonization resulting in higher yield (about 25-30 per cent compared to 20-25 per cent of traditional kilns) and a better quality of charcoal (Neuberger and Wanjira, 2015).

Efficiency improvements can be brought about by preparation of the fuelwood prior to carbonization. Typically wood is cut to appropriate sizes for optimum stacking and allowed to dry for a period of 8-10 days to reduce moisture content. Wood is stacked as tightly as possible with smaller pieces of wood fit into gaps to allow for better heat transfer(Neuberger and Wanjira, 2015).

Brick / Earth Kilns

These kilns can be rectangular, dome shaped with varying dimensions and design. They are ideal for producing high quality charcoal in large quantities and at higher efficiency (30-35 percent), and are best suited for charcoal production (Neuberger and Wanjira, 2015).

Brick kilns are expensive to build and require specialized skill in brick making and brick layering hence may not be an ideal solution where the soil conditions are not good for making bricks (Neuberger and Wanjira, 2015).

Steel / Metal Kilns

These kilns are typically drum shaped and either set-up vertically or horizontally based on design and capacity(Neuberger and Wanjira, 2015). Charcoal for export is graded and packaged to meet the international standard specification of hardwood charcoal given as:

Ash content: 3%-4%max, Volatile matter: 5-10% max, Wood matter: 2-4% max, Size: 20-120mm, Carbon: 65%-80%, and Moisture content: 8% max(Jamala, and G. Y, 2013).

The challenge of establishing an industrial scale charcoal production around the use of efficient kilns is to help charcoal producers understand the financial viability in efficient charcoal production techniques. Even though there exists technical knowledge on the use of several types of efficient kilns, the socio-economic characteristics (e.g. cost of kiln, manpower and skills required to operate the kiln, etc.) (Neuberger and Wanjira, 2015).

2.4 Socio economic importance of charcoal

The production of charcoal is an important income generating activity for many rural people in developing countries (Marlene, 2017). Additional findings further suggest that charcoal production is a vital income source when households face a crisis. Producing charcoal as one of the means to overcome the crisis. This suggests that charcoal production is an important element in households' livelihood strategies in times of crisis (Marlene, 2017).

Forest-derived incomes contribute considerably to rural livelihoods and can reduce households' vulnerability by providing a source of savings, asset building, reducing poverty levels and improving wellbeing (Smith et al., 2017).

From a macroeconomic perspective, charcoal contributes to all important elements of country development (Remedio and Domac, 2003).

1. Economic growth through business expansion (earnings) or employment;
2. Import substitution (direct and indirect economic effects on GDP);
3. Security of energy supply and diversification.

Astonishingly in Ethiopia charcoal meets a significant portion of urban households energy needs in the country, and also supports the livelihood of tens of thousands of rural people (Bekele and Girmay, 2014).

Forest resources are among several natural resources that have substantial socioeconomic, cultural and ecological importance in Ethiopia(Edward and Habimana, 2016). Charcoal is potentially renewable energy source capable of powering significant economic growth while reducing dependency of poor developing countries on costly energy imports and is a major source of income for rural households in areas with access to urban markets(Zulu and Richardson, 2013).

A review of the charcoal/poverty literature shows that charcoal production and trading offer many win–win opportunities and can help to alleviate poverty at multiple scales: enhanced government revenues from charcoal licensing and taxation and significant contribution to GDP nationally(Zulu and Richardson, 2013).

The charcoal production meeting productive energy needs in urban areas inexpensively and potentially, and increasing household incomes in both rural and urban areas while providing incentives for tree growing and conservation(Zulu and Richardson, 2013).

If charcoal is managed sustainably, production could serve as a long-term income source, especially for the rural poor, additionally revenue from permits and taxes will be sustainable, charcoal can be legal on which taxes and levies can be paid, therefore local, district, and national governments will profit (Neuberger and Wanjira, 2015).

Research study show that, charcoal production was found to be a search for livelihood by the producers. According to (Oladeji et al., 2018), charcoal production has contributed to the economic wellbeing of the producers through increase income earning.

The production of charcoal therefore served as means of generating income and generating employment. Charcoal industries in some of the top producing countries, namely Tanzania and Uganda, employ tens to hundreds of thousands of citizens, many of whom receive up to70% of their annual income from this market(Oladeji et al., 2018).

While in a number of cases charcoal production has been identified as a potential alleviator of monetary poverty, Due to population growth and urbanization it is projected that demand for charcoal will increase substantially until 2030(Vollmer et al., 2017a).

According to Menale Wondie and Mekuria, (2018) planting of *Accacia decurrens* rarely restricts other agricultural practices, as farmers are able to grow cereals between the trees in the first 2 years following the establishment of an A. decurrens plantation.

2.5 The charcoal Value chain

The charcoal value chain starts where the tree grows and the wood is cut and ends with its consumption and includes all the economic activities undertaken between these stages.

Many different stakeholders participate in the value chain; right from wood production, carbonization of the wood, packaging and transportation of the charcoal, retailing and distribution, and consumption.(Ministry of Environment, Water and Natural Resources of Kenya, 2013). In Ethiopia the main actors directly involved along the charcoal marketing chains include producers, distributors/ transporters, wholesalers, retailers and consumers(Bekele and Girmay, 2014).

Charcoal marketing and distribution is a sequence of business activities that involves the producer, supplier, wholesaler or retailer, and the consumer (Jamala, and G. Y, 2013).

The production, transport and combustion of charcoal constitute a critical energy and economic cycle in the economies of many developing nations(Jamala, and G. Y, 2013).

2.6 Demand for charcoal

The increase in demand to charcoal is likely linked to population growth and to the urbanization process at initial phases, with a large number of people shifting from fuelwood to charcoal for domestic cooking and heating (FAO, 2020). It may also closely relate to the fact that charcoal production and supply do not require an enormous amount

of upfront investment for the development of capital-intensive and durable infrastructure, such as those for electricity or natural gas, and therefore comes with lower economic and social barriers (FAO, 2020).

Demand for wood fuel in the urban areas of developing countries is usually higher than in rural areas. One of the main reasons for this is inability of the households to have access to other fuels such as gas and fossil fuels in the energy mix of the urban areas (Falcão, M. P.1, 2008).

Growth in population and income of the household stimulates the socio-economic transformation that moves households to more diverse and intensive use of household fuel. The choice between firewood and charcoal among urban families seems to be dictated, to a large extent, by poverty, with charcoal having the highest figure (Ali and Victor, 2012). The use of biomass fuel is also strongly associated with cultural preference and affordability, given the very low income of the people. The biomass users prefer wood charcoal over other biomass fuels such as crop residues and animal dung, for its higher energy release than other biomass fuels and often has excellent cooking properties among others: it burns evenly for a long time, easily extinguished and reheated and is comparatively cheaper than electricity (Alem et al., 2010). The high inflow of charcoal to the city is also due to the rise in the cost of fossil fuels such as kerosene which has become unaffordable for the poor and middle class households. The preference of charcoal for cooking some cultural food such as in the preparation of chicken sauce, in coffee as well as in church ceremonies has also given it a rise for its demand (Alem et al., 2010).

Taxing: A regulated tax system could be designed whereby charcoal produced from efficient kilns is taxed at a lower rate than charcoal produced by traditionally. Collection of taxes on charcoal can be a challenging task and an innovative enforcement system needs

to be put in place so that the tax collected from various types of charcoal is appropriately channeled back to local authorities and to a Charcoal Fund (Neuberger and Wanjira, 2015). Charcoal marketing and cost-benefit analysis depends on a study of commercial possibilities as indicated by source and cost of raw material, availability and cost of labor, price, distribution and the market for the charcoal produced(Jamala, and G. Y, 2013).

As a locally available and relatively clean fuel compared to burning wood or agricultural residues, charcoal provides basic energy services for cooking and heating to millions of people with limited options of alternatives, particularly those who live in the urban and peri-urban areas in sub-Saharan Africa (FAO, 2020).

The consumption of charcoal is mainly motivated by the cultural behavior of people living in the cities in terms of use of charcoal to cook their food. As African cities grow, the request for charcoal production has increased as well (Ali and Victor, 2012).

Charcoal production to supply the millions of energy hungered households will also continue until affordable alternative energies are sought or the cost of fossil fuel is reduced to the level that the lower income households can afford to buy it (Alem et al., 2010).

Due to this reason, it is a common source of fuel wood in urban centers(Tinsae et al., 2012). In the absence of fossil fuel, charcoal is more advantageous and much preferred fuel wood than firewood due to being of lighter weight, less bulky and more compact, thereby easier to store indefinitely and cheaper to transport. It is more efficient and produces a steady heat with little or no smoke or soot. During charcoal preparation, about half of the wood's energy is wastefully burned away(Tinsae et al., 2012).

2.7 Agricultural crop production

Ethiopia's agricultural crop production has been faced by, salinity, acidity and irrigation problems which has resulted in decline products than the potential. Salinity and salinization is a common phenomenon in the large and average scale irrigation located in the flats of the country's major river basins with predominantly salt affected soils (Merga and Ahmed, 2019). Every year around 10 million ha of agricultural cropland are lost due to soil erosion, thus reducing the cropland accessible for world food production. Totally soil is lost from agricultural land areas 10 to 40 times faster than the rate of soil development imperiling humanity's food security (Pimentel and Burgess, 2013).

Soil acidity and accompanying low nutrient availability is one of the problems to crop production on acid soils. Lime necessity for crops grown on acid soils is determined by the value of liming material, status of soil fertility, crop species and assortments, crop management practices, and economic considerations and a considerable loss in growth and yield of many food and fodder crops (Merga and Ahmed, 2019).

Human's worldwide gate more than 99.7% of their food (calories) from the land and less than 0.3% from the oceans and aquatic ecosystems, conserving cropland and keeping soil fertility should be of the highest importance to human prosperity. Soil nutrient loss is one of the most severe threats facing world food production (Merga and Ahmed, 2019).

2.8 Soil fertility problems on crop production

The damage of cropland is a serious problem because the World Health Organization and the Food and Agricultural Organization report that two-thirds of the world population is malnourished. Soil nutrient loss and associated damage to all agricultural land over many years have bring about in the loss of valued agricultural land due to abandonment and declined productivity of the remaining land which is partly made up for by the addition of nitrogen and phosphate fertilizers (Pimentel and Burgess, 2013) Soil erosion is a major problem to agricultural crop production and the environment. Most studies on soil erosion description have not focused on soil nutrient loss associated with erosion(Bashagaluke et al., 2018). Soil nutrient loss through runoff, is a major driver for soil fertility decline The eroded soil are highly concentrated with crop nutrients, which are washed away from farmlands. Soil loss reduces the agricultural value of lands via physical-chemical degradations. Erosion-based problems joined with unfavorable climatic conditions define meaningfully the productivity of farming systems in sub-Saharan Africa (SSA) (Pimentel and Burgess, 2013). Soil erosion brings to extreme losses of financial and environmental resources which negatively affect the general economies of the regions. Specific on-site results are directly observed on crop production as well as soil characteristics adversely affecting the ability of the soil to respond to management practices with time (Pimentel and Burgess, 2013). The soil nutrients lost to soil erosion process can be articulated economically to reflect the influence of erosion on fertilizer cost. The loss of soil nutrients through erosion shows substantial cost because of the need for additional to enhance sustainability of crop production systems. In minor farming systems, this cost is not measured due to lack of appropriate information. Thus, its quantification can help different stakeholders to adopt the most effective soil and crop management practices to reduce loss and improve crop productivity(Bashagaluke et al., 2018).

2.9 Charcoal and agricultural crop production

Agriculture plays a dominant role in the economic development of the country. It dominates major policies in many developing countries, it is a major source of income for most households, organizations and industries. Agriculture helps as the base of the economy as it contributes the biggest share of the Gross. Though crops, animal products, contribute immensely to the livelihood of inhabitants of the rural area. (Pimentel and Burgess, 2013) Charcoal has been found to be a major forest product whose role as a source of rural dwellers' livelihood has not been fully examined. Charcoal satisfies the energy needs of both the urban and rural living, by giving a reliable, convenient and accessible source of energy for heating and cooking at all times. From the charcoal-agriculture nexus viewpoint, charcoal and agricultural production are closely connected within a given landscape as major livelihoods. (Po, 2018).

Charcoal income contributes to supplementing shortcomings in agricultural income or to investing in diversifying livelihoods. In suggesting another method to addressing charcoal as an entry point, we suggest a specific modification to the energy-agriculture nexus. (Iiyama et al., 2017). Charcoal, is already very much a commercialized product, and rural people can get additional income from its sale.FAO (2000) had earlier proposed the energy-agriculture nexus idea to address the links between sustainable rural livelihoods and environmental protection. Biochar is a carbon rich, comparatively constant organic composite produced from the pyrolysis of biomass-derived feedstocks. Due to its constructive effects on soil properties, crop production and environment protection, biochar is being promoted and combined into soil management systems (Bashagaluke et al., 2018).

However, its effect on soil erosion under cropping systems is limitedly studied in SSA (sub Saharan Africa). Therefore biochar–crop interaction will reduce soil and nutrient losses from arable lands in SSA (Bashagaluke et al., 2018).

The charcoal agriculture nexus targeting on agriculture therefore needs to be strongly flexible to integrate the understanding of socio-ecological situations, together with key inputs and issues that all together affect livelihoods and environmental functions.

2.10 Ecological/environmental condition of charcoal production

Charcoal production in tropical areas is normally expected to have disturbing ecological and environmental effects and governments, forestry organizations and non-government institutions have been particularly concerned (Chidumayo and Gumbo, 2013).

Majority of the charcoal in tropical countries is usually made in traditional earth and pit kilns with a wood-to-charcoal conversion rate of about 20% and in 2009 the role of charcoal production to forest degradation in tropical regions with the highest rates of deforestation is estimated at less than 7% (Chidumayo and Gumbo, 2013).

Charcoal production requires a large volume of wood, which in turn depletes tree stocks causing deforestation. Thus, little is known about the actual extent of deforestation due to urban charcoal use. Neither are the social and economic patterns, which determine the charcoal exploitation, or the policy options available to mitigate the problem. This has implications for the country regarding its ability to design and implement appropriate energy policies that can intervene in the charcoal sectors. (Federal Ministry of Agriculture and Rural Development, Akure Zonal Office, Akure, Nigeria et al., 2018).

3. Materials and Methods

3.1 Description of the study area

Awi zone is located at about 430 Km northwest of Addis Ababa in Amhara national regional state. Has a total land area of 893,520 ha where 285,232 ha is agricultural land 217,139 ha is pastureland and 74,514 ha is used to other activities. The forest cover of the Awie zone is 227,845 ha which is equivalent to 36% of the area.

Fagta-Lekoma study area is one of the districts in Awi zone encompasses about 67,750 ha, which has 73% forest cover within the total land area and the population is estimated at 126,367 (based on the 2007 census) which is the last census. Most of the mountain land in the study area is degraded and devoid of vegetation subsistence agriculture is the predominant economic activity in the study area.

According to the Fagita-Lekoma district agricultural office, the forest land covers 49,194 ha, out of which plantation forest area is 45,675 ha while natural forest is 3519 ha. The cropland area coverage is 9,674 ha and 8,865 ha of land is covered by pasture. The type of crops grown are cereals and pulses including teff, wheat and barley, which are the dominant grains. The private small holders, communal and state forest are the main types of forest ownerships.

Hence, this district is known for it's widely spread *Acacia decurrens* planation with higher adoption by farmers. According to source from zonal agriculture department, since its introduction, wide scale plantation of *Acacia decurrens* were started in 2006/2007. Once it starts in this way, farmers widely adopted and spread the practice unexpectedly/ beyond their expectation. The increase in forest area coverage of the district mainly comes from the widely practiced *Acacia decurrens* plantation in the form of woodlot that gradually become large scale plantation as most farmers practiced it adjacent to each other. According to district office of agriculture, about 60% of the district is covered by *Acacia*

decurrens planation forest. Hence, this district is known for its *Acacia decurrens* plantation establishment and charcoal production in the region, which is the focus of this research study. The development and utilization of *Acacia decurrens* is considered as the best practice in the district as it was widely practiced and benefited the community.

3.1.1 Location: Administrative Map

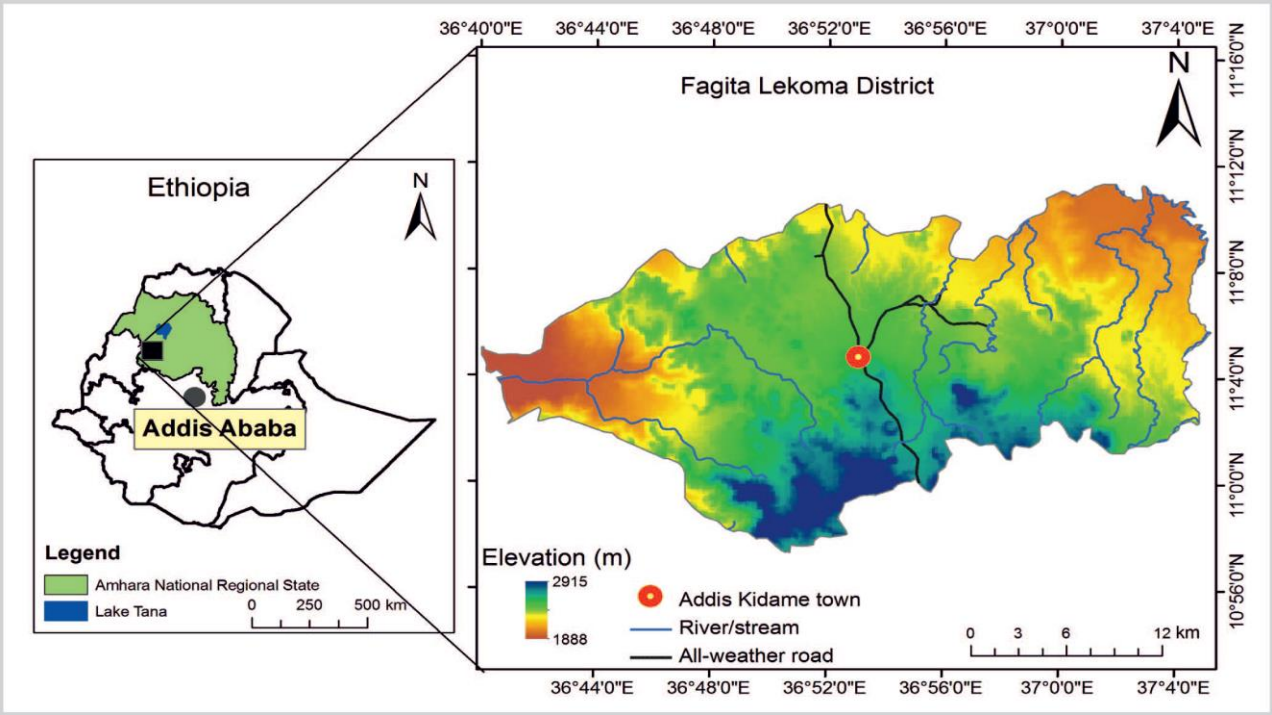

Figure 1: Administrative Map of Fageta-Lekoma District. Source (Menale Wondie and Mekuria, 2018).

3.2 Methodology

3.2.1 Sampling

The Fagita-Lekoma district has 27 rural kebeles and two town administrations. Two kebeles which are (Gendaweha and Gafera) were selected by purposive sampling method based on the existence and extensive practice of charcoal production. With the assistance of kebele development agents, house hold respondents at each kebele were selected using simple random sampling method. The total habitants' population of the two kebeles is 3360, which is around 420 HH in total (218 HH in Gendaweha kebele and 202 HH in Gafera kebele).

3.2.2 Selection of key informants

Key informants (KIs) in this study area defined as people who are currently engaged in charcoal production, but previously engaged in agriculture production and who lived there for long period of time. Additionally those who are working in the districts specially development agents in the field of forestry and natural resource and those who are the kebele leaders and influential in the area were the key informants. Therefore, based on this definition, 50 KIs (25 from Gendaweha kebele and 25from Gafera kebele) were selected. The purpose of KIs selection is to generate information on the overall aspects of charcoal production practices with in the selected district (and kebeles, in particular).

3.2.3 Household selection

At household level, necessary data related to previous agricultural production, current charcoal production practice, drivers of shifting crop to charcoal and its contribution to improving the livelihoods are collected using semi-structured questionnaire through interviewing the household heads. Therefore, household respondents at each kebele were

selected using simple random sampling method. Accordingly, from each of the kebeles the respondents randomly selected and interviewed.

Based on the general formula developed by (Yamane, 1967), at 95% confidence level; the number of household included in survey were determined by this formula,

$$\mathbf{n} = \frac{\mathbf{N}}{\mathbf{1}+\boldsymbol{N}(\boldsymbol{e})^{\mathbf{2}}} \text{---------- Equation (3.2)}$$

Where n=sample size required, N= total population size (HH) and e = precision level (5%).

Using Equation (3.2), the total Sample HH drawn is estimated as 205 HHs. Using number of households' proportion, 106HH and 99HHs are selected and surveyed respectively, from Gendaweha and Gafera kebeles.

3.3 Data collection techniques

To address the objectives of this study both qualitative and quantitative data were collected by using survey questionnaire, document review, field observation and key informant interview. The primary data are collected from sampled farmers and others, such as, district experts and development agents, who have been concerned with the charcoal production and related activities in the study area, using both formal and informal surveys. Secondary data are collected from district agricultural offices.

3.3.1 Key informant interview

The selected KIs for the study were contacted with a semi-structured checklist of subjective questions prepared in English and translated to Amharic during interview administration. The checklist prepared for interview guided the researcher to undertake the discussion with the selected key informants. Furthermore, the KIs were asked to provide information concerning changes in agricultural practices and the advantages of charcoal making practices.

3.3.2 Questioner Survey

A semi-structured questionnaire was developed and used to collect information from villagers (those involved in the charcoal production in Fageta lekoma district) to determine the drivers and the socioeconomic importance of charcoal production in the study areas. The questionnaire was used to collect information on the data on socioeconomic characteristics such age of the respondents, marital status of charcoal producers, family size, education background, production experience and gender of the respondents etc. The questionnaire was pretested before final administration to respondents.

3.3 Data analysis method

After collection of all necessary data (both qualitative and quantitative), data sorting, coding, editing and entering into statistical software were carried out. Once data entry is completed both descriptive and inferential statistics were used to analyze the data based on their nature such as percentage, mean and frequency. Quantitative data obtained from household questionnaire survey were coded and entered to the computer and analyzed as needed, finally appropriate tables and figures were generated. Descriptive statistics such as bar chart, frequency distribution, tables and percentages were used for the interpretation of results. The qualitative data were analyzed textually to supplement the survey structured questionnaire.

4. Results and Discussion

4.1 Demographic status of the respondent

The result from the survey in Table 1 revealed that most of the respondent up to 86.8% (178) of them are Male household and the rest 13.2% (27) are Female household; and also from the total household respondent 96.6% (198) of the respondent are married on the other hand 3.4% (7) respondent are divorced; and the major 119 (58%) of the respondent grouped in the age categories of from 34-49, which is actively engaged in the charcoal production and in the management tree species planted for the charcoal production like in the plantation activity, nursery management, harvesting activity; and followed by 50-70, 18-33 and >70 with the value 79 (38.5%), 5 (2.4%), and 2 (1%) respectively. In regarded to education status the result from the survey showed that total respondents 65.9 % (135) of the respondent attained primary school and 13.7% (28) attained in the secondary school which have its own implication in the adopting of new technology in the management when the farmer increase education level they are willing to adopt the new technology in the farm management and increase in the plantation activity. In terms of family number the majority of the respondents 154 (75.1%), which is possess the family size of that falls in the 5-9 and the rest of the respondents 26 (12.7%) and 25 (12.21%) with the 0-4 and 10-13 respectively.

Table 1: Socio-demographic characteristics of respondents

Demographic Characteristics	variables	Frequency	Percentage (%)
	18-33	5	2.4
	34-49	119	58
Age categories	50-70	79	38.5
	>70	2	1
	Total	**205**	**100**
	< 4	26	12.7
Family size	5-9	154	75.1
	10-13	25	12.2
	Total	**205**	**100**
	Illiterate	42	20.5
Education status	Primary school	135	65.9
	Secondary school	28	13.6
	Total	**205**	**100**
	Male	178	86.8
Gender	Female	27	13.2
	Total	**205**	**100**
	Married	198	96.6
Marital status	Divorced	7	3.4
	Total	**205**	**100**

Source: Compiled from field survey

4.2 Drivers of shifting crop production to charcoal production

From Fig.2 the survey result shows it is 60 % (123) of the total respondents gate information from the government to shift from crop production to the charcoal production, 4.4 % (9) from non-government organization, 33.2 % (68) gate information from their neighbor and 2.4 % (5) was from other sources. All farmers are not shifting at the same time from agriculture to charcoal making, but when farmers are gating information from different sources they tend to shift from crop production to charcoal production.

From Fig.3 the survey result 95.6% (196) of the respondents responded that the main cause of shifting from crop production to charcoal production is from production lose due to erosion and the remaining 0.5% (1) and 3.9% (8) of the respondent listed that absences of quality seed and mentioned other factors like lack of fertilizers and pesticides respectively. In this way charcoal production by planting fast growing tree species like (*Acacia decurrence*) has significant contribution in the minimizing the main problem of the area soil erosion and it has dual purpose by providing an alternative land use which is more profitable and serve as an alternative energy and economic sources for the area and reducing pressure in the existing natural forest of the area which experienced high rate of forest degradation from fuel wood collection and charcoal production.

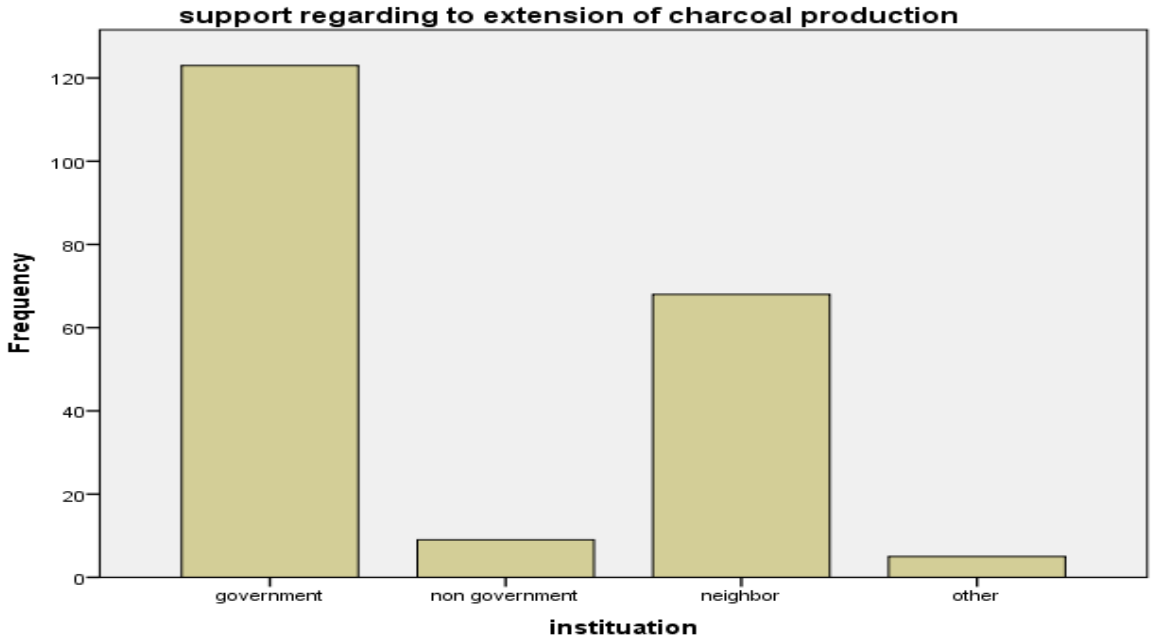

Figure 2: Different institutions supporting farmers to shift from crop prod.to charcoal prod

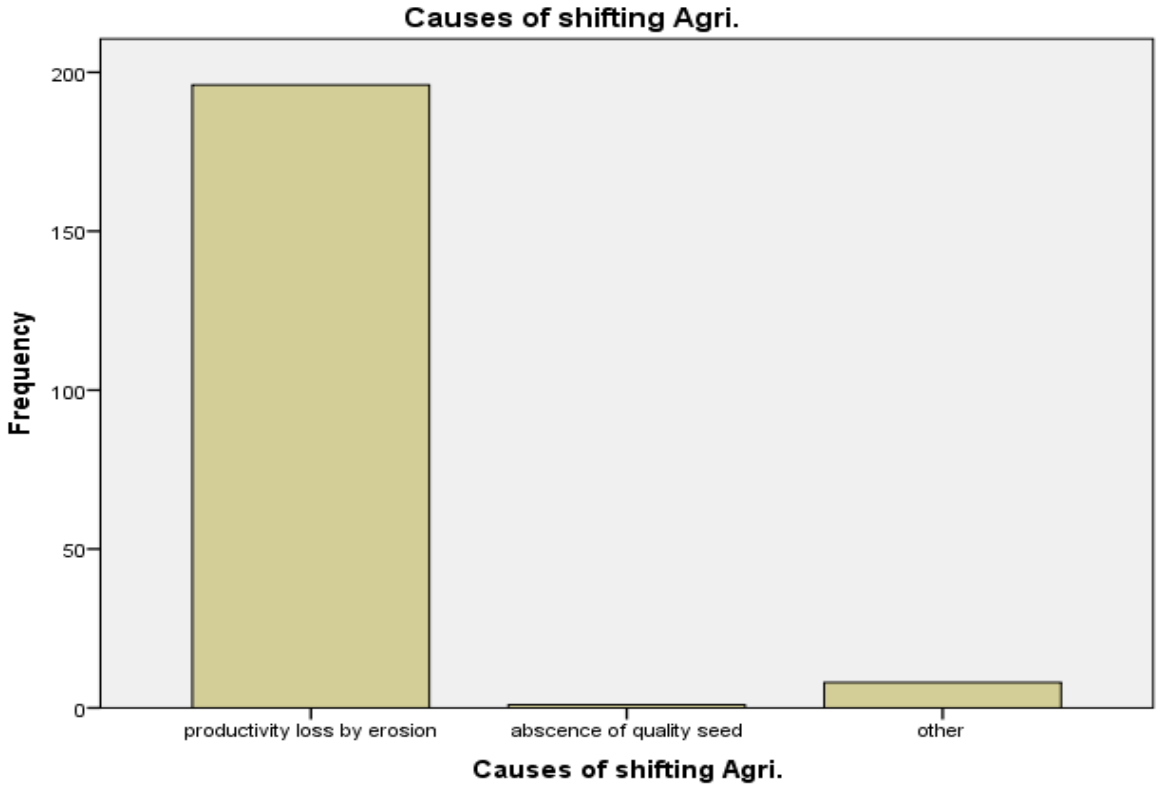

Figure 3: Different factors for causes of shifting crop prod.to charcoal prod

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4.3 Comparison of financial income generation of charcoal and crop production

From Table 2 the result shows that the gross mean annual income generation per hectare of each farmer from the agriculture sector is 10351.22 Birr, while the gross mean annual income generation per hectare of each farmer from the charcoal production sector is 27273.17 Birr. Based on this, the gross mean annual income generation of charcoal production per hectare was **2.635** times the gross mean annual income generation of agricultural production. But in order to be more reliable calculating the net annual financial income generation of charcoal production and crop production is important, therefore the study calculated the total cost of charcoal and crop production per hectare per year. Based on the information gathered from the study area the total annual cost of crop production per hectare was 4000 Birr. Therefore the net annual financial income generation from crop production per hectare per year was 10351.22 Birr-4000 Birr, which is 6,351.22Birr. Similarly in order to calculate the net annual income generation of charcoal production per hectare, we calculated the cost of charcoal production starting from seedling purchase to charcoal production. Therefore based on the information gathered from the study area the total annual cost of charcoal production per hectare was 12,000Birr, therefore the net annual income generation of charcoal production per hectare was 27273.17Birr-12000Birr, which is 15,273.17Birr. Therefore the net annual income variation of charcoal production with crop production per hectare was 15,273.17Birr-6,351.22Birr, which is 8,921.95Birr**,** this figure shows that the net annual income generation of charcoal production per hectare was 2.4 times that of the net annual income generation of crop production per year. Therefore based on this result the study concluded that charcoal production is a better business opportunity than that of crop production in terms of financial returns in the study area.

Key informant interviews established that expansion of *Acacia decurrens* plantations in degraded landscapes creates additional jobs for landless youth and provides an opportunity to diversify livelihoods income. For example, it creates job opportunities at various stages such as planting, managing, and harvesting, as well as during charcoal production and marketing of products. Charcoal production is therefore an important source of employment in the study area and a key economic activity among the rural dwellers.

The shift from crop production to charcoal production in our study area are driven by soil erosion problem. Soil erosion contributed to the less productivity of the area and reduced annual crop yield, therefore this *Acacia decurrens* is mainly attributable to its adaptability of this degraded land, fast growth nature, and potential economic benefits from the sale of charcoal and fuelwood. This all favors of the species makes the farmers to accept and adopt the new charcoal production system. The richest households are however found to have higher charcoal incomes both in economical and relative advantages. In conclusion, what the charcoal industry requires most at this point in time is an institutional acknowledgment on the part of the government as a viable sector to create jobs, and serve millions of people as source of energy and income (Bekele and Girmay, 2014). Therefore in the future probably charcoal will remain to be the main cooking fuel for most urban people in the country for some decades to come.

There were different factors that influences the charcoal and crop production labor force, fertilizer, quality seed supply, pesticide were the major factors for crop production. But for charcoal production labor source, quality seedlings and technical knowledge on charcoal production were the major factors which influences the productivity of charcoal production. Both activities had a common factor which needs the labor force, but the other factors were different for each activities, additionally charcoal production had higher initial investment cost than the crop production.

Table 2: Comparison of financial income generation of charcoal and crop production

Land use types	Gross mean annual financial income/ha (ETB)	Total annual cost of production (ETB)	Net mean annual income/ha
Crop pro.	10,351.22	4,000	6,351.22
Charcoal pro.	27,273.17	12,000	15,273.17
Difference of charcoal and crop	16,921.95	8,000	8,921.95

Source: Compiled from field survey

5. Conclusion

Here the study concluded that there is a pattern that majority of households in the study area engaged in charcoal production and charcoal business, especially *Acacia decurens* plantation establishment, charcoal making and charcoal trading have high incomes as a result. In the study area *Acacia decurrens* grower farmers do not have cooperative/association to influence market and to increase their negotiating power, due to this market price for their harvest and product is mainly influenced and guided by the middlemen/brokers, as farmers mentioned on the interview fixing the market price without the involvement of farmers on their resources is the main problem therefore, farmers to be more beneficial from their charcoal making activities they have to make their cooperatives in order to increase bargaining power. To date, charcoal stakeholders have few incentives to comply with regulations but face a significant number of compliance disincentives such as the cost of obtaining a permit, the time spent preparing information for a permit, time spent traveling to administrative offices to request permits etc.

Therefore, *Acacia decurrens* is an important source of fuel and money from the sale of charcoal. According to the development experts and key informants, in the study area plantation of *Acacia decurrens* continues to increase for the above reasons. Its expansion is considerable along the roads, which could be related to market access for forest products. Even if, currently charcoal production is widely practiced throughout the district using traditional charcoal processing method, farmers are getting a better financial return comparing to the previous agricultural practice, therefore the study concluded that charcoal production is a better business opportunity than agricultural activity.

6. Recommendations

Policies should encourage sustainable technologies and practices for charcoal production, either by establishing plantations or by encouraging regeneration, whichever is more suitable for the local environment. While Ethiopia have shown the willingness and ability to develop policies at a national level, they have been found lacking in executing the programs and actions especially at district/ regional level. Creating a charcoal agency to regulate the industry, work towards improving the charcoal technology and diversify its sources.

In sustaining the charcoal practice and ensuring social, environmental and economic benefits are equally important, the following recommendation are forwarded.

Appropriate and safe charcoal production/carbonization system and technology that have better acceptance need to be introduced and piloted.

Introduce a management system in which exploitation can be based on the capacity of the resource to recover itself.

Introduce improved technology in which existing woodlots and plantation owners produce charcoal and add value to their trees.

Assist education and research centers to focus on enhancing knowledge, and improving efficiency in the production, management and marketing of charcoal.

The government need to work towards simplifying the administrative structure, organizing the charcoal trade by setting up a transparent and differentiated revenue collection system and ensuring that institutional capacity at local/district levels should strengthened.

This study recommends adequate sustainable forest management, supervision and control practices so that the growth of charcoal production and use does not have serious negative impact on plantation forested areas.

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APPENDIX 1

Household Survey Questionnaire for Charcoal Producer

I am a student at Hawassa University, Wondo Genet Collage of Forestry and Natural resource. Now I am collecting a data for my research which is entitled "**Drivers and Economic Implications of Shifting Crop Based Economy to Charcoal Based Economy among Small Holder Farmers in Awie Zone of Amhara Regional State, Ethiopia".** The information that will be collected from you be solely used for my research and will be kept confidential. Please will you cooperate to help me by forwarding your genuine information? Thank you for your invaluable time and cooperation.

- Interviewer……..Date of interview……
- Code of respondent…….Time of interview……...

Part One: Background Information

- Kindly use tick inside the relevant box to indicate the correct answer where choices are given. Write your answer in the spaces provided where choices are not given.

1. What is your gender?

A. Male ☐

B. Female ☐

2. Age of household head ….……

3. Marital status

A. Married ☐

B. Single ☐

C. Divorced ☐

D. Widow ☐

4. What is your highest education level?

A. Illiterate ☐

B. Primary ☐

C. secondary ☐

D. Certificate ☐

E. Diploma☐

5. Your family size in number ……

Part Two: Level of income

1. Please indicate with a tick or an x in the box provided the kind if income you get in your everyday life.

_____ A. Monthly salary through a regular.

_____ B. Monthly salary. Through own business

_____ C. Regular income but not monthly –bi-monthly or otherwise.

_____ D. no regular income but there is some staggered income

_____ E. no income

2. Do you have a savings account?

A. Yes ☐

B. No ☐

3. Do you have any shares?

A. Yes ☐

B. No ☐

If yes what kind of Capital Authority shares? Please Explain

……

……

4. Do you have a loan for anything in the bank or with any microfinance institute?

A. Yes ☐

B. No ☐

Part Three: Technology/charcoal

1. What was your previous activity, your HH economy based on?

A. Agriculture

B. Animal husbandry

C. Employee

D. Other

2. How much was your average annual financial income per hectare from crop production? In ETB

_____

_____

3. How much was your average annual financial cost per hectare for crop production? In ETB

_____

_____

4. Currently what is your activity, your house hold economy based on?

A. Charcoal production

B. Agriculture

C. Employee

D. Other

5. Have you shifted from crop production to charcoal production?

   A. Yes

   B. No

6. If yes, what are the main reasons to shift to charcoal production?

A. Productivity loss

B. Absence quality seed supply

C. Absence of input supply

D. Other

7. How much was your average annual financial income per hectare in charcoal production? In ETB

_____

_____

8. How much was your average annual financial cost per hectare for charcoal production? In ETB

_____

_____

9. From whom you learnt the charcoal production?

   A. From government

   B. From neighborhood

   C. From NGO

   D. From other

10. Is there a change in livelihood economy after the adoption of charcoal production?

A. Very good

B. Medium

C. Very low

D. No change

Part Four: Key informant Interview/Discussion

1. When did you started charcoal production?

_____

_____

2. Why did you start it/ what was the purpose?

_____

_____

3. Who provided the information that initiated you to start?

_____

_____

4. Did the practice helped you to attain your aim?

_____

_____

5. What support did you get from government or anybody?

_____

_____

6. What benefits did you get from the activity?

_____

_____

7. How did you practice the activity? Continuously, per certain period of time?

_____

_____

8. What future improvement is needed in the practice?

_____

_____

9. What kind of management options did you practiced?

_____

_____

10. What are the challenges associated with the practice; product processing (list them)?

_____

_____