CHAPTER 2
LITERATURE REVIEW

2.1 Mapping Land cover/Shea butter tree vegetation cover change overtime

The area in every district is subdivided into smaller areas of approximately 4km2 plots with the help of the Hawth's tools in Arc GIS Software. Three sample plots were selected at the gridline intersection and their Universal Transverse Mercator (UTM) coordinates captured using a geographical positioning system (GPS). Thirty-two grid intersections are often selected, each having 3 sample plots, making a total of 96 sample plots for the district Shea tree inventory. The GPS unit and topographic maps were used to locate the sample plots in the field (Buyinza & Bosco Lamoris, 2015). Okullo (2016), demarcated 50x100 plot, obtained the cordinates of the trees and later used the trees vegetation index to identify other trees with similar characteristics through analysis in the GIS environment. These GPS points were used to design suitable maps for the existence/occurrence of Shea trees in each district. The Shea tree quantities were entered in Microsoft Excel as stems per hectare, processed and analysed in ArcMap GIS software. This was followed by overlaying the Shea resource map using multiple colours to display the aggregate Shea densities in area (Carney, 2007).

In addition, according to Maranz et al., (2003), over two transects are selected randomly in each in various sub counties of the district from any spot where Shea trees occur. Sampling plots of 50 x 40 meters and subplots 20 m x 20 m) and 10 m x 10 m were then set up for enumeration of the Shea trees. Study locations were selected in the dry regions of Ghana, from each of the main ecological zones where the Shea butter tree grows, (Guinea Savannah and Sudan) with the main principle being accessibility by public transport. Meteorological data was kindly supplied from Legon Meteorological department, 1:50 000 maps of Ghana were utilized to define the location, position and elevation of the site whilst others included lithology and the type of soil (Lovett et al., 2000). The major models used to determine and predict the spatial distribution of woody Shea butter plants and species diversity in savannas are established around the parameters of fertility and moisture of the soil in the area and soil fertility (Solbrig et al., 1996) together with intra and interspecific competition for these resources (Ritchie & Olff, 1999). Climatic and edaphic factors are able to account for the general terrestrial distribution of savannas, but frequently fail to explain species abundance and distribution within a particular landscape (Jeltsch et al., 1996; Couteron & Kokou, 1997).

2.2 Shea butter/Vegetation future change prediction

The change in vegetation over time emanates from the transformation of various land use types due to the effect of human activities on vegetation. As humans try to survive, they directly or indirectly clear vegetation and at the end affecting its natural distribution hence a change in land cover (Liping et al., 2018). A multiplicity of methods have been used to detect and predict the vegetation cover change over time mostly those that utilize remotely sensed data and manipulation in a GIS environment (Aniah et al., 2023). Geographic information system (GIS) Remote sensing (RS) applications are the major pertinent approaches utilized to obtain correct and appropriate geo-spatial data of land cover/vegetation change (Aburas et al., 2017). The future vegetation cover change of the shea butter tree was predicted using Markov-CA method for 1988, 1999, and 2011 using Landsat imagery data through random forest classification where 90% accurate land cover maps were produced depicting modification of the shea butter tree (Halmy et al., 2015).

A combined Markov–Cellular model was used to analyze future spatial distribution of the shea butter tree and general land use and land cover change stressed by natural and socioeconomic factors in Saga area, Japan calculated with the help of GIS technology using ArcGIS to generate the shea butter tree transition maps (Aburas et al., 2017).

The field transects were examined for vegetation cover change and land use disruption using standard army monitoring methods Land Condition Trend Analysis (LCTA)]. Concentration of various Land use activities was used as an input to develop a model to determine future vegetation cover (Liping et al., 2018).

2.3 Drivers/causes of charcoal production.

Consideration and quantification the drivers leading to massive charcoal production is incumbent before initiating the implementation of sustainable and effective forest monitoring, management practices and design successful interventions (Maranz et al., 2019). Fuelwood collection and charcoal production are commonly grouped together in forest degradation assessments. However, they are associated with different drivers and impacts. While fuelwood collection is mainly consumed in rural areas, charcoal production is driven by urban demand. This mischaracterization has led to consistent underestimations of the impact of charcoal production in forested lands (Mwampamba et al, 2013). The Eastern African countries have a large proportion of the people in the rural areas that can be categorized as poor or very poor (UNDP 2010) and in Kenyan, 44-46%of the total population, which is an improvement from 56% in 2000 are poor with 82% in rural areas (World Bank 2012). Therefore, charcoal industry, which is prevalent in rural settings due to its affordability and accessibility to the poor, could contribute to poverty reduction through alternative income-generation opportunities (Zulu & Richardson, 2013). Most of the youth in the rural settings especially young boys have often dropped from school in order to earn quick income and as such, charcoal production has in most cases been the major alternative (Walusimbi, 2001). According to Girard, (2002), the charcoal production business earns them income in less than five days with no capital investment, labour and technology apart from having access to the Shea butter tree.

The alternating wet and dry season pattern of the climate in most areas of sub Saharan Africa have also left most of the poor idle during the dry spell making them to resort to charcoal production during this period (Adam, 2009). Although charcoal production is carried out in the rainy season due to the moist wet soil used to cover the tree trunks, most of the locals also carry it out during the dry spell due to limited agriculturally viable activities and as such, the difficulty to carry out crop growing in the dry season has driven most people to charcoal production (Girard, 2002).

Population growth and migration has seen a sharp increase in the demand for charcoal as the major energy for cooking in most cities and towns of the country. Uganda's population growth rate is estimated to be 3.4% per annum which has directly exerted pressure on the forest resources and indirectly through the immense production of charcoal to meet this population charcoal energy demands (Mcparland et al., 2010). Charcoal is highly demanded by the mushrooming urban population as the cheapest energy cooking source, a circumstance that has intensified the charcoal production business (Girard, 2002). Moreover, the production is carried out by the local population in the upcountry areas while the most use is in the urban setting. Higher poverty levels in Uganda such that more than 47% of the people in country live below the poverty line (FAO, 2015). Due to lack limited alternative sources of income, the poor population is driven by the higher demand to sustain their livelihoods using available and accessible resources and as a consequence depletion of the forest cover for charcoal production becomes inevitable (Zulu & Richardson, 2013). According to Arnold et al., (2006), charcoal is not only the main household energy source for the rural and urban dwellers, it is seen as a significant source of household incomes pertinent in reducing poverty levels in the rural setting. In Northern Uganda, charcoal production has become a serious lucrative business mainly due to the fast income obtained from it within a short period of time and as such multitudes of the local communities of all walks of life have turned their attention to charcoal production (Kato et al., 2005). Moreover, even the top officials in various government institutions are now engaged in the business because of the profits obtained within a short period of time (Sedano1 et al., 2016). Whereas the standards of living of rural and urban poor people may not increase in the near future, there is consensus that both the urban population and their demands for charcoal are growing at unprecedented rates (Kituyi, 2000). The majority of African households will continue depending on traditional fuels to meet their daily energy needs for many decades to come. In particular, the demand for charcoal in most countries in the region continues to grow at high rates owing to the ever-increasing rural-urban migration. These trends, coupled with inefficient charcoal production and consumption practices, and inaccessibility by most households to reliable and affordable commercial energy forms puts in deep uncertainty the future dependence on the already-dwindling biomass resource for energy. A systems approach to sustainable biomass production and consumption as regards charcoal is proposed. Based on the life-cycle concept, the optimum policy and institutional arrangements necessary for this strategy to achieve its goal are prescribed. The strategy can be potentially adopted in all sub-Saharan African countries with various socio-economic and environmental gains. At a time when the continent is searching for lasting solutions to energy insecurity as well as reducing poverty, the strategy proposed provides such a chance for the poor to achieve this goal in the short term, while preparing them to gain access to reliable and affordable commercial energy options.

2.4 Mechanisms for sustainable charcoal production.

Sustainable charcoal production aims at minimizing material and energy losses at all stages such that the future generations ability will not be compromised through access to charcoal and the woody trees for its production (Ayhan Demirbas et al., 2016)

A systems approach (tracking material flows from extraction through disposal) is recommended to ensure sustainable material consumption at all biomass life-cycle stages (wood harvesting, Pyrolysis, charcoal use, ash disposal). Under the sustainable consumption concept, the aim is to minimize material and energy losses at all stages (A. Demirbas, 2009). In this case, wood obtained from sustainably produced biomass resource is harvested using efficient ways ensuring minimum waste is generated (Kituyi, 2000). The wood is then converted into charcoal using improved and efficient kilns after which proper handling is ensured during packaging, storage and transportation to minimize waste.

Improved monitoring of charcoal production sites under the responsibility of environmental management authorities, local leaders and protection department is paramount in reducing exhaustion of wood trees due to charcoal production (Doggart & Meshack, 2017). This involves embracing charcoal groups, associations and regulatory exploitation creating a balance between charcoal production and tree exploitation (Namaalwa et al., 2009).

According to Bolognesi et al.,(2015), charcoal producer groups introduced through the program in production areas need to work hand in hand with the local headmen in identifying suitable sites for producing charcoal and later in getting consent from the chief and receiving the necessary licenses. This would help enhance relationship among the various environment enforcement authorities and thus minimizing illegal exploitation (Jaffé et al., 2013)

Additionally, multiple activities ought to be implemented so as to ensure that there is back up support to the law and policy enforcement departments. This program can support government efforts in scaling up the formation of charcoal producer groups through the implementation of new charcoal regulations. Governments must also be supported in boosting awareness and implementation of these charcoal regulations. Inter-sectoral, multi-stakeholder dialogues across the entire charcoal value chain should be encouraged, to discuss coordinated options for reducing greenhouse gas emissions and mitigating climate change, including through such work as making the charcoal value chain a specific component (FAO, 2017).

Additional support can also be given to strengthen internal governance, legalization, operational efficiency, monitoring, and evaluation of district charcoal associations so that they can proactively engage in policy-making and improved collaboration among producers, government, as well as markets (Adam, 2009). Zambia for example has reviewed its charcoal laws, policies, regulations, and an association of producer groups has been organized as a result of exchange visits by senior government officials and producer organizations (Chidumayo & Gumbo, 2013). The first exchange visit to Kenya was in June 2015, with the Africa Farm and Family Forest producers' conference. A further exchange in June 2016 focused on visiting charcoal and nursery producer associations in Kenya. This work has already resulted in a high level of enthusiasm from charcoal producers for recognition as producer groups by government, and active participation of charcoal producers in ward development committees (Chidumayo & Gumbo, 2013).

Besides, there is an attempt to formulate a 10-year national charcoal strategy and policy to pillar along the charcoal value chain to help investigate charcoal trends over time in most developing countries in sub Saharan Africa (Mensah et al., 2022).

This also seeks to activate private sector participation and lessen wastage, risks and uncertainties of unsustainable charcoal production (Girard, 2002). In some countries of East Africa, the areas of massive charcoal production are said to have the highest environmental forest sensitivity and as such should embrace participatory tree planting programs and agricultural outreach activities by utilizing revenue from charcoal licensing activities to support these programs (Khundi et al., 2011).

Therefore, it is incumbent for producers to be strengthened through training on efficient carbonization processes through working closely with community based groups producing charcoal. The existing ten energy centres through which farmers are trained by the Ministry of Energy are important platforms that could be empowered for community technical capacity building. The country has a wide range of media celebrities such as those in music and drama, public gatherings such as in churches, and community meetings, all of which could serve as important channels for reaching consumers with messages on efficient use of charcoal (Zulu & Richardson, 2013).

Recovery of charcoal dust/fines for energy fuel briquette production Between 10–15 per cent of charcoal ends up as waste in the form of charcoal. This occurs during transportation and at wholesale and retail stalls. In Nairobi for example, about 70 tonnes of charcoal dust are produced daily at the charcoal wholesale and retail stalls. The term waste refers to something that is useless or worthless and one way of recovering charcoal dust is through production of energy fuel briquettes. Production of energy fuel briquette involves collection of combustible materials and compressing them into a solid fuel product of any convenient shape, and this is then burnt like wood or charcoal. Another option in briquette- making is harvesting of tree pruning.

Outreach and training on efficient carbonization processes through closely working with community based groups producing charcoal is vital to regulate over charcoal production (Girard, 2002). In Uganda, the Ministry of Energy is ought to establish important platforms that could be empowered for community technical capacity building, its role has been constrained by corruption (Mensah et al., 2022). The country has a wide range of media celebrities such as those in music and drama, public gatherings such as in churches, and community meetings, all of which could serve as important channels for reaching consumers with messages on efficient use of charcoal (Arnold et al., 2006).

Many local communities and government environmental bodies are aware that charcoal production is as a threat to natural resources and climate but still continue to exert pressure on it through over 80% of the charcoal being produced unsustainably production (Njenga et al., 2013). Ironically, the charcoal industry could save the environment that it now threatens if communities and private practitioners grew trees for charcoal as well as harvested trees sustainably through proper management plans and adoption of short rotational agroforestry systems (Siko et al., 2021).