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Community Forest in Liberia: The Interface between Sustainable Charcoal Production and Deforestation

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Community Forests in Liberia:

The Interface between Sustainable Charcoal Production and Deforestation

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The Barconnie/Harmonsville Authorized Forest Community

Located at the CFMB Hub Office in Bleewehn, Grand Bassa, Liberia

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Abstract

The available data establishes a direct correlation between charcoal production and forest degradation and deforestation in Liberia. Charcoal is the primary energy source for Liberians, especially in urban areas where the bulk of the population lives. It is expected to be the mainstay energy source for years to come because it is affordable, accessible, and convenient to use compared to other forms of energy (i.e. electricity and petroleum gas). However, the current model of charcoal production, based on indiscriminate felling of trees, poses a danger to the environment as it results in widespread forest degradation and deforestation. Therefore, any successful effort to combat deforestation in Liberia must necessarily tackle the current unsustainable nature of charcoal production. One way of doing so is to empower Liberians who have ownership rights to their forests through what is known as the authorized forest community program to develop sustainable yet profitable charcoal enterprises that rely on strategic methods of sourcing fuelwood and producing charcoal while maintaining the health of Liberia's precious forest ecosystems.

1. Introduction

This capstone project addresses forest degradation and deforestation in Liberia. Based on data collected, the capstone highlights the drivers of forest degradation and deforestation and focuses primarily on the charcoal sector. This capstone project is centered on charcoal because charcoal production remains an important economic activity in many rural areas of developing countries and is a vital source of energy in developing economies (Hooda et al., 2018). In most countries, the charcoal sector employs a significant workforce, providing regular income to hundreds-of thousands of people (Sepp & Sepp, 2014). However, forest areas are increasingly degraded and eventually deforested to meet the demand for charcoal. Moreover, the charcoal sector's contribution to government revenues and the broader tax base is limited due to widespread evasion of licensing fees and transport levies (Sander et al., 2010). Ineffective governance has presented a problem for charcoal producers who benefit the least from the charcoal trade. Marginalized and lacking institutional support, producers are forced to unsustainability harvest fuelwood for charcoal to support their daily needs with no care whatsoever of how that might impact forests ecosystems. The charcoal sector needs to be made more sustainable and it should start in rural communities. The devolution of forest management to forest dwellers—who live in so-called authorized community forests—is the bridge towards sustainable forest management. Accordingly, the objective of this capstone is to present the case that if sustainable charcoal production is implemented within community forests then this model of forest management can simultaneously address the demand for energy and the need to mitigate forest degradation and deforestation.

2. Literature Review

Liberia is located on the continent of Africa, in the West African region at 6^{o}N and 9^{o}W. The Country shares borders with three other nations: Sierra Leone to the northwest,

Guinea to the North, and Ivory Coast to the East. In addition, Liberia's coastline runs along the Atlantic Ocean to the South. The country is well covered by forests. It contains about 4.3 million hectares of lowland tropical forests that comprise 43 percent of the remaining Upper Guinea forests of West Africa (Jeremiah, 2015; Global Forest Watch, Figure 1). Furthermore, data has shown that forests cover around 68 percent of Liberia's land surface (Hooda et al., 2018; Karnwea, 2016). With majority of the remaining Upper Guinea forests and a large percentage of forest cover, Liberia is home to many rare and endemic species. Liberia's National Biodiversity Strategy and Action Plan (2017) states that the "forests support over 225 timber tree species, 2000 flowering plant species, 140 mammal species, 600 bird species, and over 1,000 species of identified insects" (pg. 3). The array of fauna and flora biodiversity makes Liberia one of the 35 global biodiversity hotspots, with its forest resources serving a variety of social, economic, and cultural purposes (Berg, 2017; Hooda et al., 2018).

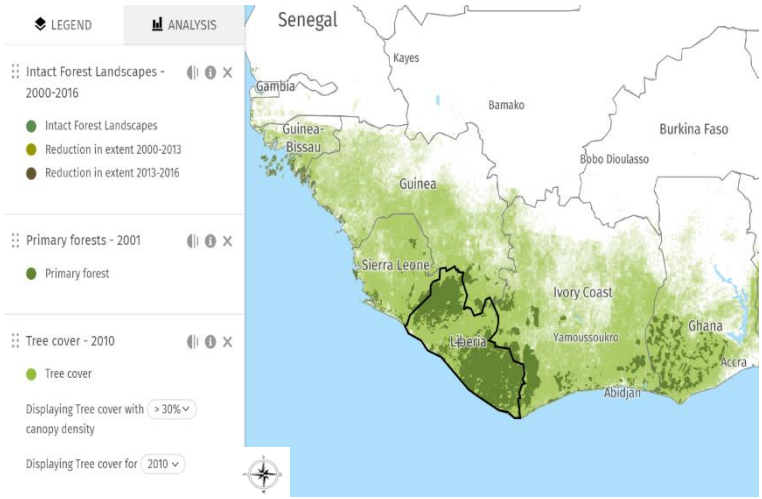

Figure 1: graph illustrates the majority of upper guinea tropical forest in Liberia. The remaining primary forest is shaded in dark green.

The Liberian people rely heavily on forest resources for their livelihoods: shelter, food, and energy (Lebbie et al., 2009). It is estimated that well over one-third of Liberia's population lives in forest areas (Hooda et al., 2018). Although the Liberian people have been blessed with a heavily forested terrain, the continuous dependence on forest resources coupled with a lack of appropriate environmental enforcement has led to mass forest degradation and deforestation in Liberia.

Forest degradation is the thinning of forests to the point that only 30% of the canopy cover remains. Whereas, deforestation is when the density of forest canopy cover is reduced below 30% (FAO, 2017). Forest degradation typically leads to deforestation and both result in serious environmental threats because trees are carbon sinks (Nabuurs et al., 2007). Trees sequester carbon dioxide *en masse*. When forest degradation and deforestation take place, an immense amount of carbon dioxide (CO_2) is released into the atmosphere (Nabuurs et al., 2007). It is estimated that in 2011, 89.8% of the greenhouse gas (GHG) emissions in Liberia came from land use, land-use change, and the forestry sector (Republic of Liberia, 2015). Anthropogenic greenhouse gas emissions are a positive feedback that warm temperatures, increase unpredictability of precipitation, and cause extreme weather events, resulting in climate change (Nabuurs et al., 2007).

Forest degradation and deforestation affect the state of ecosystem services, exacerbate the impacts of climate change, endanger plant and animal biodiversity and negatively impact the well-being of human communities. A recent study by Winrock International (Goslee et al., 2016) estimated that in Liberia more than 350,000 hectares of forests were destroyed from 2000 to 2014. While some loss of forested land is the result of natural processes, much of the current deforestation in Liberia, as in other parts of the world, results from human activities that rely on forest resources for energy, survival and to grow economies (Holland, 2017; Geist and Lambin, 2002). As population growth continues to rise in Liberia—with the population expected to double by 2042—there will be added stress on the environment as demand for resources and energy increase (Government of Liberia 2008 census). As a result, pressure on the forest ecosystems has and will continue to cause forest degradation and deforestation, unless a concerted effort is made to curtail the current unsustainable exploitation of forest resources in Liberia.

The amount of forest cover loss in Liberia derives from several drivers associated with livelihood activities and economics opportunities. As a developing country, Liberia's political leaders place a premium on economic development at the expense of the environment. They thus eagerly agree to forestry concessions for logging, palm oil operations and timber sale contracts (TSC) (Karnwea, 2016). The level of environmental impact these activities have on the forest's ecosystem creates significant land use change. For example, if all existing and proposed forest management contracts (FMCs) for logging operations were exploited this would in turn affect 24% of the total forest area in Liberia (Karnwea, 2016; Figure 2).

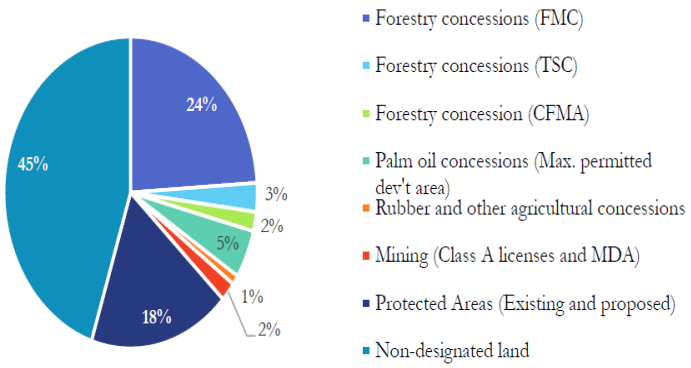

Figure 2: Percentage of the total forest area in Liberia associated with designated land uses. (Adapted from Karnwea 2016:9 Figure 2)

In addition, FMCs are often positioned near Protected Areas and cover large blocks of dense forest (dense forest is an area with 80% canopy cover) (Karnwea, 2016). Palm oil concessions and TSC account for a combined 8% of total forest area and while this number only represents one-third of forest land designated to FMCs, oil palm and TSC involve complete land clearance for successful operations. Together, conversion for palm oil plantations and TSC could amount to approximately 500,000 hectares of deforestation (Karnwea, 2016; LTS, 2016).

While economic activities for development have negatively impacted the forest landscape, egregious poverty amplifies the pressure communities place on forests (Broad, 1994). Economically impoverished communities unsustainably consume resources from their immediate environments to survive on a day-to-day basis without considering long-term impacts (Broad, 1994). In fact, the principal drivers that affect the largest area of forest land

are small-scale commercial and subsistence land uses. Activities that are associated with these land use changes are shifting agriculture, chainsaw milling, small-scale artisanal mining, extraction of non-timber forest products, and lastly fuelwood gathering and charcoal production (LTS, 2016). These activities are almost exclusively informal and involve un-taxed products and un-regulated production (Hooda et al., 2018; Karnwea, 2016).

Currently, there is limited data with which to quantify the scale and impact to the forest of these and other activities, but preliminary studies and analysis of national datasets indicate that shifting agriculture, chainsaw milling, and charcoal production are the primary drivers of forest degradation and deforestation that threaten the largest areas of forests (Karnwea, 2016; LTS, 2016). Shifting cultivation alone has affected 34% of the dense forests and 67% of the less dense forests (less dense forest is an area with 30-80% canopy cover). In terms of pit sawing, the estimated volume of timber consumed by the industry affects an area of the same size as areas affected by logging operations (FMCs), which extends to 24% of total forests. As it pertains to charcoal, a conservative estimate of the area of forest affected by charcoal production is roughly the same as that of pit sawing (Karnwea, 2016; LTS, 2016).

3. Liberia's Charcoal Sector

Liberia faces a serious problem of forest degradation and deforestation caused in part by unsustainable production of charcoal, a major energy source for millions of Liberians (Hooda et al., 2019)**.** The current population of Liberia is 5 million with an urban growth rate of 3.4% per annum. Liberia's National Energy Policy estimates that 95% of the country's population depends on energy derived from biomass. While firewood is the most common fuel in rural areas, charcoal dominates the urban energy sector, especially Monrovia (Hooda et al., 2019; Save the Children, 2001). The last official national census of Liberia conducted in 2008 found that 43.8 percent of all households use charcoal. With respect to charcoal

consumption in urban areas, the available data show that 70 percent of urban households use charcoal as their primary cooking fuel (rising to 85% in Monrovia). In 2016, per capita wood charcoal consumption in Liberia was estimated at 64.3 kg/person (Liberia's Wood Charcoal Report, 2017). Given its price advantage (compared to liquified petroleum gas and electricity), ready availability, social affinity, and evidence from other African countries, it is fair to conclude that growth in demand (Figure 3) for charcoal in Liberia will track with the rate of urban population growth (EPA, 2013; Hooda et al., 2019). Thus, it is important to recognize charcoal as a mainstay of domestic energy security in Liberia. That is why it is vital that the charcoal sector receives technical and financial support within community forests to help local communities develop sustainable forest-based enterprises. There is also a need for institutional support that incentivizes sustainable charcoal production. It is equally important to ensure the enforcement of regulations necessary to develop charcoal production as part of the formal, mainstream economy, thereby providing sustainable incomes and other benefits to those in the charcoal value chain, while standardizing sustainable forest management, thereby preventing forest degradation and deforestation.

Figure 2. Projected demand for charcoal in Liberia (2010 to 2030)

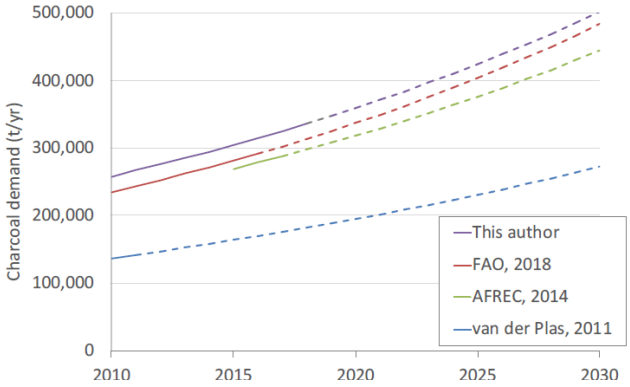

Figure 3: This graph displays the projected demand for charcoal in Liberia from several publications. X axis represents the years and y axis represents the charcoal demand in (t/yr.). This rise of charcoal is parallel to population growth in Liberia. (Adapted from Hooda et al., 2019:6, Figure 2)

3.1. Liberia's Charcoal Value Chain

Unsustainable charcoal production stems from the informality of Liberia's charcoal value chain. As a matter of fact, there is no standard value chain but instead a highly decentralized network of arrangements for sourcing, producing, transporting and selling charcoal from rural communities to urban consumers (Hooda et al., 2019). It has been estimated, when comparing Liberia's charcoal market to those of Malawi and Tanzania, that the charcoal sector employees 27,000 -28,000 people on a full-time basis and 23,500 on a seasonal or part time basis (MARGE, 2009; Tanzania Forest Conservation Group, 2018). The informal nature of the charcoal sector is due to a lack of regulation and enforcement even though the charcoal sector is, in theory, governed by Regulation No. 119-17 on Sustainable Wood-Based Biomass Energy Production and Marketing in Liberia. Regulation No. 119-17 received Forestry Development Authority (FDA) board approval and is officially under the provisions of the National Forestry Reform Law (2006) (Kamara, 2017).

Regulation No.119-17 requires charcoal producers and sellers to register themselves in associations as well as apply for a series of permits for each stage in the supply chain (i.e. Forest Use Permits, Production Licenses, Transportation Permits, and license for sales). The Regulation No. 119-17 also sets a list of 51 tree species that may not be felled for charcoal production, provides a schedule of registration fees for producers, transporters and exporters and a schedule of volume-specific fees or production, transport and export (Kamara, 2017). However, the FDA has shown weak institutional governance regarding the implementation of Regulation No. 119-17. It has been reported that most FDA staff seem unaware of the Regulation No. 119-17 as none of the required forms are available from the FDA and no application and approval systems are in place for people who seek to comply (Hooda et al., 2019).

The FDA's failure to enforce Regulation No. 119-17 has allowed actors throughout the charcoal value chain to evade compliance requirements. For example, charcoal workers are without permits and certified licenses, fees associated with transporting charcoal to the urban community are not payed (i.e. waybill fees), and retailers of charcoal sell to end users without licenses. Accordingly, actors throughout the informal charcoal value chain operate freely and, when detected, bribe corruptible or uninformed officials (Peter & Sander, 2009). If the cost of compliance exceeds the cost of evasion, then those who produce, transport and trade in charcoal will always opt for evasion (Hooda et al., 2019). In any case, weak governance, lack of monitoring and enforcement within the charcoal sector will allow for bad habits and unsustainable practices.

The charcoal value chain begins at the source. Liberia's charcoal comes either from indigenous hardwoods (i.e. Uapaca guineensis aka mango trees*)* or from over-aged rubber wood (*Hevea brasiliensis*). The indigenous hardwood species produce charcoal known as 'iron coal' due to its high burn temperature and low ash production. On the other hand, charcoal produced from rubber trees (also known as softwood) is referred to as '"light coal" because it does not provide the same quality of burn as hardwood species (Hooda et al., 2019). Charcoal from hardwood species can be sourced from primary forests, from which forest reserves are cleared for the first time (usually for FMCs and TSCs) under license from the government. However, charcoal can also be sourced from unreserved forest areas or village lands illegally by actors without licenses, indiscriminately felling trees (Sepp & Sepp, 2014). But typically, charcoal from hardwood species comes from secondary forests in areas of shifting cultivation as a by-product. In fact, a recent study in Liberia of natural resource value chains found that 39.1 percent of charcoal comes from 'clearing of land for farming purposes' (UL-PIRE, 2016). Charcoal from rubber wood is made from trees aged 25-30 years from which latex production has diminished (Hooda et al., 2019). Wood fuel supply from this

source is expected to continue as rubber trees are clear and re-planted systematically for commercial production. As of now, charcoal from old rubber trees is the only known sustainable source of charcoal because of the replantation cycle but research indicates that rubber plantation only account for 1% of total forested areas in Liberia (LTS, 2016).

There is an obvious problem with the way charcoal is being sourced in Liberia. Trees are either cut down for the sole purpose of charcoal making (primary product) or collected from land cleared due to shifting cultivation (by-product) without attempting silvicultural practices to restore its ecosystem. Additionally, wood is sourced in unreserved locations without formal consent and licenses, which makes it difficult to account for the volume of wood lost in forest areas for charcoal production (Sepp & Sepp, 2014).

Given the way charcoal is sourced as a primary product in Liberia, it is very likely to lead over time to forest degradation and ultimately deforestation because the rate at which trees are harvested for charcoal will exceed the average annual rate of the forest growth cycle, especially when considering a rising urban population (Makundi and Sathaye, 2004).

In terms of charcoal made as a by-product, the key activity is shifting cultivation, which is the most common form of subsistence farming in Liberia because it provides fertile soil for crop production. However, this farming practice only allows for a couple harvesting seasons because the area is ‘slashed and burned, which means tree growth is severely stunted and most of the nutrients from the land are consumed by the crops that were harvested. Afterwards, the land is non-valuable for crop yield and farmers are forced to shift to another forested area and continue clearing land. These current livelihood practices are considered unsustainable as they add stress on the forest ecosystem and potentially amplifying the effects of climate change. Therefore, these livelihood practices must be addressed in such a way that those involved can still benefit monetarily without degrading the environment.

Next in the charcoal value chain is the production process. This step involves two types of producers, the professional charcoal producers and the short-term charcoal producers. The professional charcoal producers depend on charcoal making for their livelihoods. These full-time producers typically have business relationships with the owner or occupier of a forested land that has been cleared for farming or other business interest. Short-term producers are usually farmers who clear their own land for cultivation. For farmers, charcoal production provides additional income to help support their farm and other expenses (i.e. medical cost, funeral expenses, school fees, marriage ceremonies) (Peter & Sander, 2009). Charcoal producers exclusively use basic earth kilns, which is the traditional method of making charcoal across Africa (FAO, 2017). Wood pieces are completely covered by dirt, grass and earth until a mound is form. Once the mound is completed and tightly packed, at the top of the mound a large stick is inserted to create an airway shaft to make the fire burn better. The large stick is then removed, and the process known as carbonization takes place. Carbonization is initiated by heating a pile of wood under low oxygen conditions with a limited supply or air. High temperatures induce the absorption of heat, which leads to the decomposition of biomass until the carbonized material, charcoal, remains (FAO, 2017).

The efficiency of the carbonization and quality of the charcoal depends on several factors such as: the moisture content of the wood (drier biomass produces more charcoal), the density and the diameter of the wood, tree species (i.e. whether softwood or hardwood), wood stacking, skill of the producer, climatic conditions and lastly the type of kiln – whether earth, brick, or retort kiln. A study conducted by CAMCO (2014) has shown that the estimated fuelwood-to-charcoal conversion ratio for the traditional kiln is between 9-30%. This process of making charcoal has a lower efficiency when compared to the other forms of kilns (i.e. brick kilns 27-35% or retorts 22-40%) and is extremely difficult to manage, most especially during the rainy season because precipitation can disrupt the exposed earth mound and slow

down the carbonization process. However, charcoal producers have not moved away from the traditional earth kiln because it can be set up near the 'source' site, its infinitely size-flexible, no capital requirement is needed, and there are no incentives to invest in an improved kiln when there is unregulated access to forest resources (FAO, 2017; Hooda et al., 2019). In the end, the traditional earth kiln is it a good fit for the informal system of charcoal production that dominates the sector (FAO, 2017; Hooda et al., 2019).

Kiln efficiency is one of the most significant contributors to unsustainable charcoal production. The low efficiency of traditional kilns means that substantially higher wood inputs are needed to produce the equivalent quantity of charcoal produced in an efficient kiln (FAO, 2017). Data suggest that traditional kilns might require up to 12 kg of wood to produce 1 kg of charcoal, whereas some modern kilns require only 3kg to produce the same amount of charcoal (FAO, 2017). The average charcoal bag weighs 23.5 kg, which indicates that it can take up to 282kg of wood to produce one bag of charcoal when using the traditional earth kiln. As stated above, if the average person uses 63.4 kg of charcoal a year, it can be deduced that 760.8 kg of wood is needed to provide charcoal for each person in Liberia. The amount of wood depleted for consumer use is staggering given the millions of people that live in Liberia. This goes to show the seriousness of forest degradation and deforestation in Liberia as a result of the massive reliance on charcoal as an energy source.

4. Urban Community Interview Responses

As it stands, charcoal production will increase in Liberia because of population growth and urbanization. We cannot refute nor change this outcome. Urbanites are stakeholders within this values chain, and their consumption of charcoal is what contributes to constant felling for wood supply to feed the urban demand. While interviewing nine urban community members, the first set of questions asked were designed to determine: whether the

informants had an appreciation for forests, whether they knew how important forest resources are, and if they could identify the causes of deforestation.

The first question: What does a forest mean to you? In summary, the informants see the forest as a large area of land covered with trees that inhabits a biodiverse ecosystem of flora and fauna. The forest is essential to the livelihoods of humans as it protects communities, provides food, offers a peaceful place for cultural practices and allows for revenue generation from the harvesting of forest resources. What was commonly conveyed in each of the informant's response was that the forest means "life." Without a doubt the informants demonstrated through their responses that they have a fond appreciation of forests.

The second question: Primarily what are forest resources used for? In summary, the responses to this question reflect a common consensus that forest resources are primarily used to support livelihoods and economic growth. Resources such as water, wood, charcoal, food (i.e. bushmeat and spices) and medicinal plants are used daily. For example, one informant said that "wood is used for construction purposes and charcoal is used for household purposes, which are essential for community development" (interviewee #15). Another informant interestingly referred to forest resources as "items in a supermarket" (interviewee #2), with the forest as the supermarket and various forest resources as items in the supermarket. Furthermore, forest resources also nurture subsistence farming, with forests being slashed and felled trees stacked and burned for crop production. In terms of economic growth, timber, palm oil, mining, coal etc. are exported and used for national development (i.e. build schools, infrastructure development and reinvestment into economic sectors).

The third question: What are the main causes of deforestation? The consistent drivers of deforestation reiterated throughout each interview were shifting cultivation to carry on

subsistence farming, fuelwood harvesting for charcoal production, unregulated third-party contracts approved by the government for logging and mining ventures, and overpopulation, which has forced rural communities to cut down parts of the forest to establish new homes. In a nutshell, a lack of education on how to manage forests sustainably, companies taking advantage of the uninformed by extracting forest resources unsustainably, and government's disregard for the health of forest ecosystems have led to forest degradation and deforestation.

When analyzing the responses from these three questions, it is evident that the informants are well-informed about the importance of forests ecosystems to the well-being of Liberians. Without directly saying it, each informant explained the ecosystem services that forests provide. In fact, the informants listed several resources from the forest that are used daily to support livelihoods and economic activities. Therefore, there seems to be a strong attachment to the forests. However, because Liberians are so dependent on forest resources for income generating opportunities, their forest-based livelihood activities eventually become unsustainable and lead to forest degradation and deforestation.

Informants' responses to the third question regarding the main causes of deforestation show that they understand the link between their unsustainable use of forest resources and deforestation. Indeed, there was a marked similarity between their responses and the data provided by published and unpublished literature. We can reasonably conclude that informants are aware that the livelihood activities that take place in Liberian forests (fuelwood harvesting for charcoal production, shifting agriculture, etc.) are major contributors to deforestation and forest degradation.

The fourth question: Per informant, how many charcoal bags are used on average in a month? The responses showed that an average of three 50kg bags with a charcoal net weight of 25kg are used a month. However, this number is a bit skewed because some respondents have more family members at home than other respondents.

The fifth question: How important is charcoal for your daily activities? And why? All respondents answered that charcoal is necessary for daily activities. This is because the lack of electricity is a major problem in Monrovia and other urban centers. Currently, less than 3 percent of Monrovia's population is connected to the pubic electricty grid. Those who can afford a generator use it sparingly because of the high cost to run the machine. So the only reliable fuel source that can remedy Liberia's household energy dilemma is charcoal and it is used daily for several domestic activities such as cooking, heating water for bathing, and ironing clothes. Moreover, charcoal is perceived to be safer to use than cooking gas. A respondent explained the "cooking gas almost burned down the house because the tank was left open" (Interviewee #1).

The sixth question: What is the average price for a standard charcoal sack? And have you noticed an increase in price? If so, how much? The informant's responses confirmed the view that there is no standardized pricing. The price for a standard 50kg bag depends on the exchange rate (how well the economy is performing), location (the transportation cost), and is predicated upon what the seller charges. Most charcoal consumers currently pay 550 Liberian Dollars (LD) or 2.79 United States Dollars (USD) in along the suburbs of Monrovia. However, within the central part of Monrovia people can pay up to 984 LD or 5.00 USD. A couple of informants explained that in the past people were paying 150 LD for a bag, however the price has increased over the years (due to inflation) and in 2017 a bag of charcoal was 250 LD. Last year it went up to 400 LD. It appears economic conditions make it difficult to maintain stability in the price of charcoal. A noticeable response was that "because of constant felling of trees for home building and charcoal production near Monrovia, people are forced to drive further into rural communities to gather fuelwood for charcoal" (Interviewee #3). Therefore, people pay an increase price to cover the distance it takes to retrieve charcoal.

The seventh question: Do you use briquettes? Each informant said “no” and was not familiar with this alternative eco-friendly fuel source. Interviewee #3 said that the “Liberian community does not have the technical capacity to produce briquettes on a commercial level.”

The eighth question: Is charcoal preferred at home over other fuel sources? Overall, the informants said charcoal is preferred at home over other fuel sources for a couple reasons: charcoal is less expensive than electricity and cooking gas. Charcoal is also perceived to be safer than gas and electricty. An informant explained that charcoal can be controlled by the “little ones.” The informant then explained that “for cooking gas there are many problems. If a child turns the gas on too high it can explode, and electricity can easily catch on fire. Once the household is done using charcoal you can direct a child to sprinkle water or pour sand on the charcoal to stop the fire” (interviewee # 5). Additionally, “left-over” charcoal is easy use because it is easy to reignite it. Interviewee # 18 explained that there is a colloquial saying within the Liberian community, “old fire trunk isn’t hard to catch.” Lastly, charcoal is more convenient than firewood because it emits less smoke and charcoal bags are easier to carry around than a pile of firewood. However, interviewee #3 stated that “prior to the war, residents in Monrovia were not using charcoal for cooking; they were using electricity. But because of the war, electricity generating and distributing infrastructures were destroyed.” Accordingly, charcoal is a preferred energy source because not everybody has access to electricity, and even when there is access, electricity tends to be significantly more expensive than charcoal.

The ninth question: Where do you get your charcoal from? The informants said they purchase their charcoal from community retailers or from local markets. Retailers from the community and markets purchase charcoal bags from wholesalers near production sites in nearby rural communities.

Given the current level of charcoal dependency, a sustainable strategy must be implemented to transform the way fuelwood is sourced and produced into charcoal. If not, charcoal production will continue to be a major driver of forest degradation and deforestation. The suitable solution is to engage community forests to sustainably produce charcoal as a forest-based enterprise. This approach can help turn charcoal production from a driver of forest degradation and deforestation into a valuable source of income for forest dwellers that is compatible with sustainable use of the forests. And perhaps community forests are the best place to begin experimenting with sustainable charcoal production.

5. Community Forests

Community forests represent a ground-breaking recognition that communities – not the state and private companies – should control forests (Witness, 2018). This strategy conserves forests as resources and protects their biodiversity to maintain livelihoods and food, water and shelter for people. Unregulated (open) access to forest resources and the unchecked exploitation of their resources inevitably leads to deforestation [Open access → Undervaluation of wood → Inefficient production and use → Wasteful use *or* High opportunity cost → Conversion = Deforestation] (Sepp & Sepp, 2014). Experts and states widely recognize that security of land tenure is one of the most significant conditions necessary for sustainable forest management (Christian et al., 2016; Sepp & Sepp, 2014). In 2009, the Liberia government recognized land tenure for local communities by enacting the *Community Rights Law*. The law sets forth a nine-step process for forest dwellers to attain "authorized community forest status," which confers upon them the right to exclusively own, manage and use their forest resources (Christian et al., 2016; Meadows & Litz, 2017).

5.1. The Nine Steps to Authorized Forest Community Status

Communities that wish to have their rights to forest lands formally recognized must first *submit a letter of application for authorized forest community status (*AFC*)* to the FDA.

The application shall include the "location of the area of forest resources and information on the community's livelihood activities as it relates to the usage, preservation and development of forest resources in the area" (Meadows & Litz, 2017:3). In addition, the application must contain the following objectives: first, to manage and use forest resources in a sustainable manner, and maintain the forest as an ecosystem; second, to encourage and build upon existing community traditions, which promote the preservation of the forest and sustainable forest management practices; third, to promote environmental conservation and ensure biological diversity; and fourth, to work closely with the FDA to ensure the success of the community forestry program (Meadows & Litz, 2017; Witness, 2018). These objectives are legally required and must be met before any other steps can be taken. Once this application is submitted, an FDA official and The Community Forest Working Group assess whether the community has met all application requirements.

Upon approval, the next step involves *a 30-days' notice given to the community and adjacent communities for a socio-economic survey and resource reconnaissance*. The notice shall be given in the form in which communities usually receive public information (i.e. posters, radio announcements, letters). The FDA officials also serves a copy of the notice to the recognized leaders of the community applying for AFC status and recognized leaders of adjacent communities (Meadows & Litz, 2017; Witness, 2018). After the thirty (30) day notice, FDA officials with the consent and involvement of community members, *begin the socio-economic survey and resource reconnaissance*, covering the area of forest resources the community wants to use as its community forest (Meadows & Litz, 2017; Witness, 2018). FDA officials and community members collect data about the area and the forest resources and how they are used and then compare it with existing data on concessions and protected areas to ensure there are no obvious conflicts or competing claims (Meadows & Litz, 2017; Witness, 2018).

Once the socio-economic survey and resource reconnaissance has been conducted, the FDA and recognized leaders *post another 30-days' notice to inform the community and adjacent communities that the demarcation and mapping of the forest area* claimed by the community will take place (Meadows & Litz, 2017; Witness, 2018). During this stage, the FDA drafts and delivers letters to "other relevant agencies" and local government authorities to inform them of the upcoming demarcation and mapping of the forest area proposed by the community. The intended letter puts the other agencies on notice in case their assistance is needed to resolve any disputes that emerge and go beyond forest resources (Meadows & Litz, 2017; Witness, 2018). Following the end of the thirty (30) day notice period, *the area of forest resources that the applicant community proposes for a community forest is demarcated and mapped*. After completion of the survey/reconnaissance, the demarcation and mapping of the forest area, *the results of these two exercises are posted for 30-days* within the applicant community and adjacent communities for members to review (Meadows & Litz, 2017; Witness, 2018). Subsequently, the FDA arranges a meeting with communities in order to explain the results and technical details, answers any questions that community members may have, and verifies that the data from the survey and report on the demarcation and mapping are accurate.

At the end of the required thirty (30) day period, communities may either proceed to step seven or step eight depending upon the outcome of posting the results from the survey and report on the demarcation and mapping of the areas of forest resources proposed for the community forests. If official objections have been submitted by members of the community applying for AFC, or by members of adjacent communities, then step seven, *the dispute resolution process* is next. However, if no official objections are submitted during the thirty (30) day period, the FDA directs the community applying for AFC status to proceed to step eight, *to establish the forest governance institutions* (the Community Assembly (CA),

Executive Committee (EC) and the Community Forest Management Body (CFMB)) (Meadows & Litz, 2017; Witness, 2018).

In order to establish the forest governance institution, The FDA drafts and delivers a letter to the Office of the County Superintendent, requesting that the County Administration staff organizes a general meeting of community members from the villages applying for AFC status, and adjacent villages. At the meeting organized by the County's Administration staff, the FDA informs the members of the villages to post a public notice to inform community members about: the date of the elections for community representatives that will sit on the CA (the highest decision-making body of the community); the first General Meeting of the CA to determine the make-up of the CA, elect the Officers of the EC (those who handle the administrative side of community forest matters) , and determine the criteria for the CFMB (members that manage the community forest); and the second general meeting of the CA to appoint CFMB members; elect the Chief Officer, Secretary and Treasurer of the CFMB; and develop a constitution, set of governing bylaws, and forest rules (FDA officers assist in drafting of these documents) (Meadows & Litz, 2017; Witness, 2018). Once the applicant community has formed its CA, EC, CFMB, and adopted a constitution, governing bylaws and forest rules, *the FDA shall issue a Community Forest Management Agreement* (CFMA) *for review and signature,* which is the ninth and final step. In order to obtain final approval to participate in the community forestry program, the CFMB must agree to and sign the CFMA with the FDA and the applicant community will officially be known as a *community forest* (Meadows & Litz, 2017; Witness, 2018). Recognized as a community forest, the CFMB can now draft a community forest management plan,which lays out how the forest will be used. Once completed, the draft recieves approval from the EC, CA and FDA and the implementation stage begins.

5.2. Assistance During the Nine Step Process

As a community navigates the nine-step process, it is equipped with external technical and financial support from local and international Non-Governmental Organizations (NGOs). Access to NGOs is of fundamental importance in setting communities on the path towards sustainable forest management as they provide legal expertise, forest management planning, mapping, resource assessment advice, governance support, and funding (Christian et al., 2016). For example, USAID has funded ACDI/VOCA USD $23 million to implement a five-year program called Forest Incomes for Environmental Sustainability (FIFES). The goal for FIFES is to develop key rural forest-based businesses which provide inclusive, sustainable economic opportunities for smallholders and communities that combat drivers of deforestation and biodiversity loss (Impact, 2018). FIFES provides support and training by strengthening selected forest value chains – cocoa, indigenous tree species, wild honey, bushmeat and charcoal; by establishing legal and management frameworks for forest businesses, and by enhancing knowledge and skills for forest businesses and landscape management (Christian et al., 2016 Impact, 2018).

5.3. Sustainable-Forest Based Enterprise

By achieving the nine-steps and receiving technical and financial assistance from NGOs, a community forest demonstrates that it has the capacity to successfully manage its forest resources, something that is vitally important in forest conservation. However, it may be exceedingly difficult for a community to sustainably manage its forest resources in the face of significant increases in the cost of living and demand for food and energy in a developing country, such as Liberia. Nevertheless, customary land ownership may help foster forest conservation even in difficult economic times because community members who have a vested stake in their land and forest resources through customary land ownerships are

more likely to be willing to engage in sustainable exploitation of resources on lands that they know legally belong to them.

As important as it is to fostering conservation, customary land ownership alone does not provide a panacea for forest degradation and deforestation. Indeed, if there are limited income opportunities for community members, then the communities, even if they have customary ownership to their lands, will still be forced to deplete their resources and degrade their lands as a means of survival. Accordingly, the key to sustaining forest resources and thereby reducing the rate of forest degradation and deforestation is to help forest communities develop *sustainable-forest based enterprises* that produce income generating opportunities to help alleviate poverty, without causing forest loss. In Liberia, a CFMB has identified *sustainable charcoal production* as a business opportunity that can generate income for forest communities while contributing to sustainable forest management and conservation.

6. A Sustainable Charcoal Production Case Study: Barconnie/Harmonsville Authorized Forest Community

Located in Grand Bassa County in the South Eastern portion of Liberia (ACDI/VOCA GIS map, Figure 4). The Barconnie/Harmonsville Community brings together twenty-one (21) towns that have successfully completed the "Nine Steps" process for gaining Authorized Forest Community (AFC) status under the Community Rights Law of 2009. Barconnie/Harmonsville AFC has demarcated a portion of land for conservation purposes, thereby protecting the land from any livelihood activity or contractual agreements with logging companies. To ensure that their

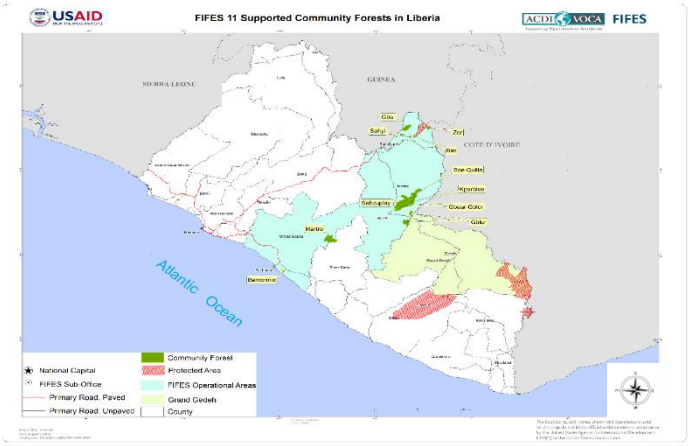

Figure 4: Map created by T. Stewart Sherman *GIS Specialist* for ACDI/VOCA. Barconnie/Harmonsville is the community forest, highlighted in yellow, located right along the Atlantic Ocean

energy, income, and food demands are met, Barconnie/Harmonsville requires that all livelihood activities take place along the greater landscape (a forested area surrounding the community forest that members can use for livelihood activities). Pursuant to the Community Rights Law, Barconnie/Harmonsville AFC has reached a required level of technical capacity to access and sustainably use forest resources to generate income for the benefit of its members. Accordingly, Barconnie/Harmonsville has now shifted its attention to income generating opportunities and recently developed a strategic 5-year business plan for producing sustainable charcoal in the greater landscape area.

Barconnie/Harmonsville was the source of useful data critical to understanding how sustainable charcoal production could help to mitigate forest degradation and deforestation. A total of ten interviews were conducted with Community Forest Members, four of whom were also Charcoal workers in the community. Just like the interviews that were conducted with urban community members, the first set of questions asked Barconnie/Harmonsville Interviewees were designed to determine: whether the informants had an appreciation for forests, whether they knew how important forest resources are, and if they could identify the causes of deforestation. The next set of questions were targeted at both stakeholders (i.e. community forest members and charcoal workers).

6.1. Community Forest Members' and Charcoal Workers' Response

The responses provided by the community forest members and charcoal workers were also similar to the responses provided by the urban community members. The informants in Barconnie/Harmonsville believe that the "forest means life; the forest provides us with an ecosystem, food, fuelwood and medicine." Majority of the informants' responses confirmed that Barconnie/Harmonsville members have an appreciation of the forests. However, there was a response from a charcoal worker that proved why shifting cultivation is one of the major drivers of deforestation in Liberia. Interviewee #10 stated that "forest means

uncultivated bush, a bush where no farming activity has taken place." This response stood out from the other responses because it illustrates how some people may see the forest "as an area where no livelihood activity has taken place yet" rather than a "vital ecosystem that provides essential services for the betterment of humanity." For the two questions regarding use of forest resources and causes for deforestation, the informants explained that forest resources allow for the building of homes, businesses, roads and schools. and the overwhelming causes of deforestation, was shifting cultivation to feed the demand of a rising rural population.

6.2. Community Forest Members' Response

Rural communities in Liberia are not connected to the electric grid. *So, when asked what main source of energy do, they use for household activities,* the Barconnie/Harmonsville community members replied by saying "firewood and charcoal." Without biomass energy, their daily meals cannot be prepared. The next question was *what livelihood activities take place within the community forest?* The responses to this question revealed that the *community's greatest source of income* came from small-scale charcoal production and fishing. The members also asserted that all forest related activities were not conducted within the community forest but instead within the greater landscape.

Regarding land use management for shifting cultivation and charcoal making, it was revealed that while trees are cut down during the process there is no reforestation that takes place. This feedback came as a surprise at first because of the technical assistance and environmental awareness the community forest members have received. However, there is a cost for seeds to replant trees and almost all the community members are involved in subsistence livelihoods that generate just enough revenue for daily needs. Getting seedlings entail an additional cost that is of their least concern, even though the community members are aware of the consequences of not replanting trees.

The last question for the community members was *whether they were satisfied with the current activities or our there any livelihood activities they would like to see implemented*? The members were not so interested in implementing an additional livelihood activity but to rather improve the scale of their current activities, specifically charcoal production, while ensuring sustainability.

6.3. Charcoal Workers' Responses

The forested area of Barconnie/Harmonsville encompasses several different tree species. During their interviews, the charcoal workers explained that *the type of trees that are used to make charcoal* are *Uapaca guineensis* (mango trees), *Parinari excelsa* (rough skin plum), Acacia (exotic species), and *Hevea brasiliensis* (rubber trees). Rubber trees are used for charcoal making in the community when age-old trees are felled at rubber plantations and sold to charcoal buyers.

However, rubber trees are categorized as softwood tree species and have a lower calorific value compared to hardwood tree species which means that the charcoal produced from rubber trees will burn faster, emit more smoke and produce a higher ash content than charcoal produced from mango, acacia, and other hardwood trees (FAO, 2017). Understandably, therefore, mango trees, rough skin plum, and Acacia are the preferred trees to use for charcoal making. All fuelwood for charcoal making is taken from the greater landscape. There is currently no system or enforcement in place that takes into account how many trees are cut down in Barconnie/Harmonsville or how many tons of fuelwood is consumed during each carbonization process. So, the greater landscape could lose considerable forest cover if charcoal workers harvest at a rate that exceeds the natural growth cycle of the Barconnie/Harmonsville forest. Charcoal workers in the community currently use

the earthen kiln method to produce charcoal (Photo, Figure 5). When asked, *how can the charcoal value chain be improved on your end*, the charcoal workers replied that "we need to improve the method we use to produce our charcoal. Also, trees should be planted only for charcoal purposes to prevent felling all trees in the greater landscape."

Figure 5: The traditional earth kiln in Zolo Village, Grand Bassa, Liberia. A village linked to the Barconnie/Harmonsville Community forest Network. (Photographer: A. Clement, 2019)

6.4. Barconnie/Harmonsville Proposed Sustainable Charcoal Enterprise[1]

The results from the interviews confirmed that the Barconnie/Harmonsville Community Forest Network are aware of how valuable the forest is to their survival. However, even when practicing conservation within the community forest, community members conduct all of their livelihood activities in the greater landscape area. As such, if there are no sustainable practices implemented and enforced within the greater landscape, the forest area of Barconnie/Harmonsville will eventually be depleted to a point where livelihood activities will start taking place within the community forest. Therefore, as stated earlier, Barconnie/Harmonsville has developed a business plan for sustainable charcoal production. Because income generation is a major problem faced by community forests, this business plan, if successfully implemented, will allow for income generating opportunities that will help to improve the standard of living for the community members, thus lessening the clear-cutting of trees for charcoal in the greater landscape, which, in turn, will help reduce the rate forest degradation and deforestation.

[1] The business plan was developed with funding provided by FIFES.

Pursuant to the business plan, the Barconnie/Harmonsville AFC intend to purchase a mobile retort kiln for sustainable charcoal production (Photo, Figure 6). Using a mobile retort kiln will allow for the enterprise to shift its charcoal production activities from one part of the forest to another. The mobility of the retort kiln will help to minimize the depletion of fuelwood in any one area, hence allowing natural forest regeneration after five to seven years. Using a mobile retort kiln for sustainable charcoal production will also allow the enterprise to provide unhindered and uninterrupted supply of charcoal to the market. This is so because the mobile retort kiln can easily be mounted under a shelter whereas the traditional earth kiln is extremely difficult to manage, most especially during the rainy season, as it is common to see damaged earthen kilns due to heavy rain. On average, during the dry and rainy season, using a mobile charcoal retort takes approximately eight hours for one production cycle while a traditional earth kiln requires twelve to twenty days depending on the weather conditions. Another disadvantage when using the traditional earth kiln is that its fuelwood-to-charcoal conversion ratio is lower as compared to the mobile retort kiln. The mobile retort kiln is expected to obtain approximately 32% fuelwood-to-charcoal conversion while the earth kiln ratio, at best, is estimated to obtain a 23% conversion rate. Not only does the mobile retort kiln provide an improved conversion ratio, it also produces better quality charcoal that burns longer and creates fewer ashes. With all the advantages that come with the mobile retort kiln, charcoal workers could hypothetically reduce the frequency with

Figure 6: The Exeter Mobile Retort Kiln with a trailer attached. Retort Chamber Capacity – 1.7 cubic meters, approx. 500kg of fuelwood. Production cycle: 8-10 hours. Return per cycle: 170-195kg of charcoal. (online photo from Carbon Compost Company).

which they enter the greater landscape in search for fuelwood. Barconnie/Harmonsville investment in the mobile retort kiln will thus allow for a commercial size operation that can bring additional incomes for the community. Moreover, revenue made will also be reinvested to sustain the enterprise.

The key component essential to sustainable development for this enterprise is the creation and maintenance of a woodlot. In order to sustain the fuelwood for annual sustainable charcoal production, the enterprise pursuant to the business plan (with help from Liberia's Forest Training Institute and the Sehkinpah Tree Nursery) will survey a portion of the greater landscape, preferably degraded lands, which is the ideal method for sustainable sourcing wood as it allows for reforestation and prevents the conversion of natural forests (FAO, 2017). The creation and maintenance of a dedicated woodlot will serve as the future inventory supply of fuelwood. Within this woodlot, fast growing indigenous tree species (*Uapaca guineensis and Parinari excelsa*) and exotic tree species (i.e. Acacia) will be used as the primary plants for the woodlot. Furthermore, silvicultural practices will take place to ensure that the regeneration rate of the trees are equal to or more than the rate of depletion. The woodlot will cover 21 hectares of land area, resulting in 288 trees per hectare, accumulating to 6,048 trees total. This woodlot will be divided into sections so that the community members and charcoal workers will be able to systematically rotate harvesting cycles throughout the woodlot to prevent depletion of trees. The development of the woodlot within the greater landscape will help to prevent community members from indiscriminately cutting down trees for charcoal production.

In addition to the charcoal production, the members of Barconnie/Harmonsville are interested in collecting agricultural waste from the farming that takes place throughout the greater landscape. Resources such as: corn stems and leaves, groundnut shells, palm oil kernels, sugar cane, banana peels and stems, coconut husk, rice husk, etc. can be used to

produce briquettes, an alternative energy source for charcoal. Creating briquettes is similar to producing charcoal. The agricultural products must be completely dried and placed in a kiln (i.e. 200L oil drum or brick kiln) to go through the process of carbonization. After the carbonization process the carbonized material is mixed together with a binding ingredient (i.e. cassava paste) and then formed by hand or machinery into a briquette. After 3-4 days of drying in the sun, the briquette can be used just like charcoal. This ingenious way of providing energy for household activities will allow the community to increase their revenue which in turn will help towards sustaining the forest-based enterprise as well as providing a buffer for fuelwood harvesting.

It is worth stressing the point that Barconnie/Harmonsville main purpose for going into the charcoal production business is to make profit. Employing strategic advertising and marketing campaigns, Barconnie/Harmonsville plans to target specific charcoal purchasers, such as wholesale charcoal distributors, schools, restaurants, hospitals, clinics, street sellers, households and concession workers. Barconnie/Harmonsville has access to markets in the city of Buchannan located in Grand Bassa County and in Monrovia, the largest urban population center in Liberia with 939,524 people. With an initial investment of USD $17,800, this enterprise is expected to realize a return on investment of approximately 174% over five 5 years. Annual sales are projected to increase by 25%, and net income is estimated to be 55% of gross sales turnover. Barconnie/Harmonsville AFC will therefore benefit greatly from producing charcoal sustainably.

7. Lessons Learned & A Way Forward

Barconnie/Harmonsville business plan presents key steps that can be taken within community forests to allow for sustainable charcoal production. Once their plan is implemented, Barconnie/Harmonsville will be the first community forest in Liberia to sustainably produce charcoal as a forest-based enterprise, making them a trailblazer in the

fight to reduce the charcoal sector's impact on forest ecosystems while establishing an income generating opportunity to uplift their lives. Moving away from the traditional kiln and investing in a mobile retort kiln improves the forest regeneration rate in that: first, the mobility of kiln eliminates intense harvesting in one location; second, the fuelwood-to-charcoal conversion ratio is better than the traditional kiln which lessens the frequency in which charcoal workers go into the greater landscape to harvest; third, the mobile kiln allows for unhindered and uninterrupted supply of charcoal to the market providing a sustained cash flow which allows for reinvestment back into the business to help towards the establishment of a woodlot.

The community's idea to create and maintain a woodlot will ensure the availability of sustainable wood in an area and thereby reduce pressure on the greater landscape while restoring degraded lands (FAO, 2017). A successful example of a woodlot program in Africa is in Madagascar where an individual-based reforestation scheme from 2002 to 2014 had produced, by 2010, an afforested area of 6500 hectares in 57 villages and a sustainable supply of wood for more than 80,000 urban wood fuel consumers, and it had avoided the deforestation of 49,000 hectares of natural forest (GIZ, 2014). In addition, growing specific tree species within the woodlot will ensure that there will be enough fuelwood supply to prevent outside harvesting. For example, fast maturing Acacia trees usually grow tall upright, single trunk form, and reach 20-25 ft. in height and 10-15ft. in width in about 5-6 years. Acacia trees are low maintenance trees and can grow under warm and harsh tropical weather. Lastly, the woodlot allows for a long-term management plan rather than opportunistic harvesting because it creates the environment for implementing a silvicultural system for sustainable extraction of fuelwood, thereby not exceeding the mean annual increment of biomass growth within the woodlot (Bailis et al., 2013; Hooda et al., 2019). The mean annual increment (MAI) is the average annual rate of wood or biomass growth over a growth cycle

of a forested area; its value depends on species, site productivity and management regime (makundi and sathaye, 2004). Harvesting at a rate that exceeds the MAI will, over time, lead to forest degradation and ultimately deforestation.

Barconnie/Harmonsville has the opportunity to collect agricultural waste to produce briquettes, which is an alternative to charcoal that could substantially reduce pressure on community's wood resource (UNDP, 2013). In Sub-Saharan Africa (SSA) alone, it is estimated that 140 mt of waste from cereal stalks and husk is generated annually (Dasappa, 2011). Yet, in Liberia, this method of producing energy is non-existent. A World Bank report (2009) explained that access to, and recoverability, of forest residues in SSA may be constrained by the region's poor transport infrastructure, which proves to be true in Liberia. However, Barconnie/Harmonsville can easily access several agricultural waste sites within their community forest, thanks to the unification of the 21 towns. And while not introduced in the business plan, an agglomeration of charcoal dust and left-over logging residue can also be used as an alternative source for charcoal production.

Charcoal dust results from charcoal breakages during packaging and transporting. Traditionally, producers and traders considered charcoal dust a "menace to their businesses and therefore had not put in place plans for its use or conversion to briquettes" (KFS, 2013:33). However, recycling charcoal dust to produce "charcoal briquettes" reduces wood demand and pressure on forest resources. Studies have shown that charcoal dust collected at production sites, and retail shops could produce more than 15 percent more cooking fuel (Njenja et al., 2014). Moreover, charcoal briquettes have been found to save an equivalent volume of trees that would otherwise be cut down for charcoal (Njenja et al., 2014).

Just as the case with charcoal dust, left-over logging residue is not currently utilized to make charcoal. At the moment, logging is permitted on customary land under commercial use contracts that AFCs sign with commercial operators for long-term forest exploitation

rights (Hooda et al., 2019). During logging operations, vast quantities of logging residue are generated and currently left to rot. Logging residues are left at two locations: at the felling sites within the forest, where the tree stump, crown and branches are left behind as the trunk is transported out; and at consolidated log landings, where the wood is graded and scaled in preparation for outward haulage by trucks, generating large volumes of off-cut buttresses and rejected trunks (Hooda et al., 2019). The amount of residue generated depends on species and local practices, but best available estimate assumes 60% wastage from Liberian commercial forestry operations and total annual availability of 6,898 million tons of air-dry wood (Milbrandt, 2009). Calculations provided by The World Bank report on Opportunities for Charcoal and Sustainable Forest Management (2019) states that at "19% conversion by weight this could produce 1.3 billion tons of charcoal per year, close to 4,000 times the current national demand" (pg. 19). If the wood at the felling and landing sites were made available for community forest use than charcoal workers could potentially avoid harvesting fuelwood from the greater landscape.

Sustainable charcoal production is achievable in Liberia. The investment in improved kilns and woodlots, the use of alternative fuel sources from agricultural waste, and the collection of charcoal dust and logging residue are potential solutions to help mitigate forest degradation and deforestation in Liberia caused by unsustainable charcoal production.

However, because fuelwood harvesting takes place in forested areas surrounding rural communities, the most effective way to transform the practice of charcoal production is through AFCs. Community forest consist of elected members that help to protect their areas forest resources to maintain the health of the forest ecosystem. Community forests tend to easily develop strong partnerships with NGOs that provide technical and financial assistance towards sustainable forest management. But most importantly, community forests can implement sustainable forest-based enterprises, which are the key incentive to restore

degraded forested areas in Liberia, prevent deforestation for the consumption of charcoal, which ultimately reduces the risk of climate change feedbacks throughout Liberia. When other community forests throughout Liberia hear about the success of Barconnie/Harmonsville sustainable charcoal enterprise, they will be very likely to follow suit, which in turn will help create a system of sustainable practices that can be transferred to other livelihood activities that prove to be a threat to Liberia's forested areas.

8. Methodology Review

Data for this capstone was collected by conducting semi-structured interviews. Key informants, including community forest members, urban community members who use charcoal, and charcoal workers, were recruited to participate. The purpose of interviewing these three informant communities was to gather qualitative data to discover their relationships with charcoal and the forest as a resource. Each respondent answered 8-9 questions per interview. Before contributing, each participant read the consent form, written in English, which apprised them about protections to their anonymity and confidentially. A total of nineteen people participated. This capstone also gathered data from exiting published and unpublished literature to offer insights and quantitative information about the degree of deforestation and demands for biomass energy in Liberia. Collected data from pre-existing documents was compared against data gathered from project interviews.

Initially, science-driven statistics on charcoal production, transport and trade in Liberia were supposed to be included in this capstone based on analyses of National Forest Survey in Liberia. This Survey is intended to gather data that can provide an accurate estimate of the total market size of the charcoal industry and quantify charcoal demand factors, such as route, timing and mode of transportation. Additionally, the Survey, which was to be conducted by the Liberia Forest Sector Project was to produce the first nationally representative forestry survey to collect initial data on charcoal production in forested areas

with communities. The goal of the project is to provide baseline data on various forest product value chains in Liberia, including charcoal sale, processing, consumption, and the cost incurred. In addition, the data will also provide information on individual households, from which total dependence (based on self-consumption and sale) can be derived.

A total of 3,000 households and 250 communities from all 15 counties in Liberia, living within 15km from the forest were interviewed. Depending on the quality and reliability of data produced from the Survey exercise, it could form the basis for a more ambitious knowledge and data platform on the charcoal industry extended to investigations of value, employment and livelihood benefits. However, while conducting the capstone, it was discovered that Survey was not conducted, and the relevant data was therefore not available. Accordingly, most of the quantitative data presented above from published and unpublished literature were "estimates" and not up to date. Secondly, this capstone was meant to analyze satellite imagery for reliable measures of historical changes in forest cover in Liberia, due to charcoal production. However, GIS mapping programs such as Google earth and global forest watch did not provide me with clear evidence of forest degradation and deforestation from "charcoal activities".

The informality of the charcoal sector combined with the lack of initiatives from government agencies to gather relevant data makes it difficult to determine the true impact this industry has on Liberia's forested area. Additionally, because of limited data, and no active trace of sustainable charcoal production throughout Liberia (Barconnie/Harmonsville AFC currently at the implementation stage), it is impossible to provide quantitative data on how effective sustainable charcoal production might be in reducing the rate of deforestation.

Nonetheless, the data collected, while not ideal, did allow this capstone project and paper to draw conclusions strong enough to support the paper's stance on how to transform unsustainable charcoal production in Liberia, by implementing sustainable charcoal

enterprises within community forestry which in turn can mitigate forest degradation and deforestation. the key informant interviews and literatures suggest that: Liberian urban community members rely heavily on charcoal for their household activities. Urbanites' dependency on charcoal generates employment opportunity for rural Liberians. To supply the demand for charcoal, rural Liberians unsustainably fell trees because they are not forced to comply with the regulations set forth by the FDA due to minimal and/or non-existent enforcement. From data collected from Barconnie/Harmonsville AFC, reforestation and afforestation projects are currently not in place. Rural community members not replanting trees affects the forest growth cycle thus directly contributing to forest degradation and deforestation as data suggest that charcoal production and other small-scale activities threaten the largest areas of forest. So, to prevent the depletion of forested areas for charcoal, sustainably producing and sourcing fuelwood for charcoal should be encouraged. Due to the level of awareness, conservation training, and NGO assistance, a sustainable forest-based enterprise involving charcoal, should be implemented especially for AFCs that have access to city markets. Therefore, we can deduce that community forests actively partaking in sustainable charcoal production will have a positive impact on Liberia's forests.

Gathering useful data from the urban community members was not difficult. All the key informants were literate and spoke English well. There was no need for relationship building before conducting the semi-structured interview. When asked, the potential interviewer would either agree or disagree to be a part of the research.

As it pertained to gathering data from charcoal workers and community members, there was some challenges. In rural Liberia illiteracy is high. Several key informants did not understand certain open-ended questions and a couple of respondents needed assistance from other villagers. A couple of key informants were given hard copies of the semi-structured interview questions to review but decided not to participate because they were not

comfortable in their English. Also, because of the relationship with FIFES, there was easy access to Barconnie/Harmonsville. Without a well-connected Liberian or NGO staff in rural villages, the chances of conducting semi-structured interviews would have been low, unless relationship building was established first, which takes time. Additionally, due to poor infrastructure, it was difficult to coordinate trips, acquire a village guide, and reserve accommodations in other community forest areas within the timeframe to complete the capstone project, so all key informants derive from Barconnie/Harmonsville. In terms of the style used in conducting semi-structured interview, the original approach was to ask key informants a set of open and closed-end questions without allowing the key informants to look over the questions. However, the quality of some responses was not as robust as when the key informants had time to review the questions before hand.

9. Ethical Review

Liberians are impoverished. This capstone project accounted for this vulnerability. No interview involved cash payment for participation. All interviews were conducted with written consent in English (the official language of Liberia). A few initial partakers declined to participate. The interview questions avoided any potential controversy and potential harm to participants. There was no formal relationship between the student researcher and participants, who were Liberian rural community members, urbanites, and charcoal workers. This capstone project is for educational purposes only. This research did not share the identities of participants in any instance and will not share the collected data beyond this capstone project and paper. All data from the capstone project was stored on a password-protected personal computer.

10. Findings and Discussions

10.1. What regulatory strategies and incentives can improve the cost effectiveness of sustainable charcoal production for community forests?

Poor governance of the charcoal trade due to weak enforcement and ineffective regulations, discourages communities and entrepreneurs from investing in sustainable and regulated charcoal trade because sustainable charcoal will be at a higher price than unregulated charcoal (Vos & Vis, 2010; Witness, 2018). This is because wood that is illegally or unsustainably harvested to produce charcoal is free as the producers only incur labor costs (Peter & Sander, 2009). As discussed in this capstone, the charcoal sector in Libera is governed by Regulation No. 119-17 and approved by the FDA. The Regulation No. 119-17 stipulates that each stakeholder (i.e. charcoal producers, sellers, transporters and traders) within the charcoal value chain should adhere to the mandatory process of applying for permits and licenses to formally conduct business in this sector (Kamara, 2017). However, because of the time and cost it takes for individuals in rural areas to travel to the FDA coupled with the lack of institutional capacity from the FDA (i.e. uninformed/illicit officials, no system put in place for available forms, applications and approval) many stakeholders are willing to evade compliance and illegally produce charcoal (Hooda et al., 2019). This means that a key challenge for a community forest that wants to sustainably produce charcoal as a buiness venture is the unfair competition from the unscrupulous industry actors who can sell charcoal at a price that undercuts charcoal produced sustainably (Hooda et al., 2019; Peter & Sander, 2009).

So to encourage community forest members to support sustainable charcoal production, there will need to be stricly enforced regulations that address the charcoal sector. This begins with reforming the FDA from the top-down. An official investigation should take place to uncover the illicit FDA officials who benefit from the informal charcoal sector. The World Bank report on Opportunities for Charcoal and Sustainable Forest Management (2019) stated that “bulk transporters are required to pay FDA a fee of US 1.6 cents per bag for a charcoal waybill fee only at the first checkpoint they encounter en route to market. The

revenue collected is meant to go to the government's Consolidated Fund, overseen by the Ministry of Finance, though FDA is not able to provide any information on the amount raised" (pg. 9). Furthermore, a carbon copy of each waybill fee is supposed to be sent to FDA headquarters by checkpoint staffs but there are no collected records of these payments. This means that there is no way of tracing the quantity of charcoal being transported or the revenue collected (Hooda et al., 2019).

The absence of information on the amount of money raised and collected as well as records of payments, insinuates a high level of corruption taking place within the FDA. There are checkpoints with staff positioned at county boundaries and road junctions. Moreover, there are only three major roads that lead into the capital city, Monrovia (Hooda et al., 2019). So there is no way for transporters to evade the waybill fee unless checkpoint staffs receive a form of bribery from transporters, many of whom are unlicensed, then the bribe money presumably end up in the hands of selected FDA officials. Indeed, this research did not uncovered concrete proof that waybill fees end up in the pocket of FDA officials. However, it is highly conceivable that this is what happens since waybill fee payments and records of payments should be a normal procedure conducted by checkpoint staffs and accurately reported to the FDA.

To conclude, once these illicit individuals have been apprehended there should be legitimate vetting procedures put in place to ensure that the next batch of FDA officials are upholding to their duties and enforcing regulations for the forestry sector. Once the corruptible and uninformed officials are expelled, the government should implement strict regulations and sanctions to ensure that the cost of trading illegally produced charcoal will be higher than the costs of charcoal that is licensed and regulated (Peter & Sander, 2009; Vos & Vis, 2010). The government, along with the FDA should also provide fiscal incentivess for formal actors. These incentives would allow for reduced licensing costs for charcoal and

could be implemented by removing the waybill fee from charcoal produced in an Authorized Forest Community (Vos & Vis, 2010).

To monitor whether charcoal was produced and traded formally or informally, a proposed option to introduce branded biodegradable bags to distinguish sustainably produced charcoal could be be an effective model. The consumer would have to tear the seal when accessing the charcoal which prevents the bag from being reused (Peter & Sander, 2009). Taking these steps and strictly enforcing other relevant regulations could serve to level the playing field for community forests seeking to enter the sustainable charcoal production business and make them more competitive.

Additionally, to produce sustainable charcoal, community forests will need initial capital to purchase necessary items for woodlot development and charcoal production (i.e. seedlings, hardware equipment, assorted tools, pesticide & fertilizer application, an improved kiln, warehouse construction, water pump machine etc.). Also, community forest members will need capital to pay workers, hire consultants and technical support. This sustainable business endeavor can prove to be costly. Currently in Liberia, community forests' main sources of funds to start-up an enterprise are either local and/or international NGOs and grants from programs most of which funded by USAID or other international aid organizations. The government and FDA can play useful roles here by provide small loans for community forest mangement bodies to help as start up capital for their sustainable enterprise.

10.2. Is a Community Forest a Front for Deforestation?

On the surface, a communty's quest to apply for a community forest status is to ensure that sustainable forest management and conservation planning will take place. This way, the forest will continue to produce a complete range of goods and services not just for this generation but future generations as well (GoL, 2009). When a community has attained

authorized status, the Community Rights Law of 2009 stipulates that responsibility for sustainable management of the community forest ultimately lies with the community (Witness, 2018). However, while this might be the purpose of establishing a community forest, there are reports and investigations that have exposed a dark secret involving community forestry in Liberia: Logging companies are hijacking the community forest program and using it to unsustainably exploit forest timber.

Compared to neighboring countries with significant tropical forest such as Ivory Coast and Ghana, Liberia has been the most progressive in providing an opportunity for forest dwellers to manage their lands through Community Forest Management Agreements (Witness, 2018). In particular, communities must complete the Nine Step process to officially be labeled an Authorized Forest Community. However, there is a cost associated with everything. Throughout the Nine Steps completion process, communities will end up paying thousands of US dollars for registration fees, surveys, demarcation and mapping of proposed areas and for the mobilization of community gatherings. The local communities do not have the resources or money and simply cannot afford to complete the Nine Steps without financial and technical assistance from an outside source. So against the backdrop, a number of logging companies have entered the frame, and often promise the communities financial assistance to complete the process, although their actual intent is simply to make profit off community forestry in Liberia (Witness, 2018). Therefore, rather than collaborating with communities and fairly negotiating agreements about what happens to the community's forests, logging companies are instead taking advantage of weak rules and insufficient guidelines while disempowering many local communities through deception to attain their vested interest (Witness, 2018).

More specifically, logging companies have found a way to control a large portion of community forest land by: one, entering early on in the nine step process and promising

profits from logging, jobs, infrastructure development and then proceed to take over and control the community forests before they have even been awarded authorized forest status. Two, misleading communities into signing secret contracts that give away their rightful ownership of forest resources. Three, bribing politicians, local elites and FDA officials so that agreements are signed in secrecy that grant logging rights and thus forcing Liberia's forest ecosystem away from communities and into the hands of logging companies, and lastly four, exploiting legal loopholes that allow them to maximize their profitability whilst keeping them in the least regulated category (Witness, 2018).

Throughout Liberia's history, forest communities have always been deprived of their own resources, specifically through commercial forest activities. Liberia's forest resources have been exploited at an alarming rate for the benefit of the rich and well-connected individuals (Williams, 2006). In 2003, the United Nations imposed timber sanctions on Liberia due to the corruption, revenue embezzlement and depletion of forest resources. In 2006 the sanctions were lifted under the leadership of former President Johnson-Sirleaf. Her administration reviewed previous logging activities, cancelled existing timber concessions and introduced a new forestry legislation, the National Forestry Reform Law of 2006, that outlined sustainable practices (Ford, 2012; Lavalah & Johnson, 2017). Part of the law allowed for the issuance of Private Use Permits (PUPs) which were supposed to be granted only to individuals or rural forest communities with the goal of preventing large scale exploitation of forest by large commercial logging companies. However, this effort to ultimately halt deforestation backfired as highly placed government officials and well-connected individuals abused PUPs so that the actual beneficiaries of the permits were the big logging companies. It is estimated that over 2.5 million hectares, or 23 percent of the land area of Liberia was handed over illegally to loggers through these permits up until their cancellation by presidential decree in 2013 (Witness, 2018).

Due to the massive fraud, misrepresentations, abuses and violations of the National Forestry Reform Law in the issuance of PUPs, the FDA has not issued any new commercial logging concessions since 2012 and has stated that it has no plans to issue any more in the future (Witness, 2018). So, logging companies have now turned their attentions to CFMAs because at the moment they are the only avenue logging companies have to access new forest areas. In other words, the entire PUP process has been transformed into community forests.

The CFMAs encourage communities to commercialize their forests, both to improve local economies and develop infrastructure. But with the help of some corruptible local elites and FDA officials, logging companies are able to manipulate communities into believing that they are too uneducated to manage the forest themselves and would benefit from having the logging companies as technical experts (Witness, 2018). Communities are than told by the FDA that obtaining a permit is costly. Even worse, the FDA provides little to no financial support and without assistance from an NGO, forest communities are coerced into signing agreements with logging companies even before applying for community forest status. Logging companies fund the entire Nine Step process and once the community forest permit is obtained, the logging companies are in charge once again (Witness, 2018). Logging companies are aware that many communities are desperate and can easily be duped by people with money. This is a serious disadvantage for communities who want to own and manage their land sustainably. Currently the practices taking place in community forests (those without NGO assistance) are not suited to the community-empowerment objectives envisioned in the Community Rights Law. Consequently, community members are being sold a lie and are effectively "fronts" for resource exploitation, eventually leading to deforestation.

With help from NGOs, the community forest model embodies a sustainable approach to forest management and conservation. In addition, it allows communities launch sustainable forest-based enterprises that provide additional income generating employment opportunities

and helping to achieve poverty alleviation. However, without NGOs assistance, it would be to a community's best interest if the FDA suspends the approval of any more authorized community forests until a full and effective regulatory framework is in place, along with associated guidance, templates, technical assistance, transparency and accountability mechanisms (Witness, 2018).

11. Conclusion

With proper technical and financial assistance, granting communities control of their own forest through community forestry is beneficial for the forest ecosystems and for the welfare of the Liberian people. Community forests can prevent deforestation by avoiding relationships with large commercial logging companies and developing a management plan that allows for a strategic forest-based enterprise that can create prosperity and self-sufficiency in the community. In addition, through community forestry, the impacts of climate change, a global critical issue that humanity is currently faced with, can be mitigated in Liberia due to sustainable forest management through the practice of conservation, reforestation and afforestation. Replanting trees and protecting the forest ecosystem allows for the forest to regenerate which will help to sequester carbon dioxide thus preventing the detrimental positive feedbacks that derive from increase carbon dioxide in the atmosphere from forest degradation and deforestation (i.e. extreme weather events, increase temperatures, desertification and etc.).

Charcoal production has the potential to be a sustainable forest-based enterprise. However, the charcoal sector in Liberia is currently informal and due to the lack of enforcement and monitoring, the thousands of stakeholders that partake in this industry are currently negatively impacting the forest areas of Liberia because, as already indicated, charcoal production is a main driver of forest degradation and deforestation in Liberia. Charcoal will be the mainstay fuel source in Liberia for years to come. Charcoal is

affordable, easily assessable, and a social affinity for the Liberian people. Correspondingly, population growth and urbanization will magnify the demand for charcoal consumption. Therefore, there must be sustainable initiatives put in place to reduce the unsustainable amount of harvesting for fuelwood that is taking place in Liberia's forested areas and the inefficiencies in the way charcoal is currently produced. This capstone project and paper proposes the idea that engaging community forests to implement sustainable charcoal production will help to mitigate the pressure this sector has on the environment. However, in order for a community to invest in this style of production there must be the right incentives. Communities need to have the opportunity to benefit financially from community forestry or else the unsustainable practices that have occurred over the years in Liberia will continue.

The Barconnie/Harmonsville AFC 5-year strategic business plan is pioneering sustainable charcoal production. Based on their business plan, they will invest in a mobile kiln that will produce quality charcoal in an efficient manner compared to the traditional earth kiln. Additionally, the mobile kiln allows for the enterprise to shift its charcoal production activities from one part of the greater landscape to another to minimize the depletion of fuelwood and allow for a natural forest regeneration. The enterprise will also create and maintain a woodlot which is the key feature within the business plan that will enable sustainable development. The woodlot will contain fast growing indigenous and exotic trees and by applying a silvicultural system, the woodlot will allow for a constant supply of fuelwood for the enterprise. Another piece of the business plan proposes collecting agricultural residue to create briquettes which is an alternative fuel source that can help to limit fuelwood harvesting. This enterprise is expected to realize a return on investment of approximately 174% over five years. Annual sales will increase by 25% and net income is estimated to be 55% of gross sales turnover. Once Barconnie/Harmonsville established this business they will be the first community forest to sustianably produce charcoal. Their

success will provide a roadmap for other AFCs to implement sustianble charocal prodcution as a profitable livelihood activity.

The Government of Liberia along with the FDA needs to improve its support for community forestry and provide incentives that will help AFCs compete with the unscrupulous actors in the sector. Sanctions and fines should be imposed on those who are illegally producing and transporting charcoal. Corruptible and uninformed officials should be removed or re-educated about their duties and tasks. Monitoring systems should be in place to detect those who evade compliance. Overall, the charcoal sector needs to be reconstructed in a way that systematically protects the environment and prevents forest degradation and deforestation. Linking community forestry and sustainable charcoal production can be an ideal model that makes the charcoal sector a part of the formal mainstream economy, providing sustainable benefits to those in the value chain while at the same time incentivizing sustainable forest management.

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APPENDIX 1: Consent Form and Interview Questions

Consent Form

This interview is part of the Capstone Project: *Sustainable Charcoal and Community Forest Ecosystem Management*. The interview is intended to collect data about communities that have gained authorized community forest status to understand the relationship they have with their forest ecosystem.

Your participation in this study is completely voluntary. There are no foreseeable risks associated with this project. However, if you feel uncomfortable answering any questions, you can withdraw from the interview at any point or skip a question. Your response is appreciated and will be of great help. Your identity will be kept anonymous and confidential. Thank you very much for your time and support.

Your Signature indicating your willingness to participate:

Date of Signature:

Semi-Structured Interview Questions

1) What does "forest" mean to you?
2) Primarily what are forest resources used for?
3) What are the main causes of deforestation?
4) How many charcoal bags are used on average in a month?
5) How important is charcoal for your daily activities?
6) What's the average price for a standard charcoal sack? And have you noticed an increase in price? If so, how much?
7) Do you use briquettes, Yes or No?
8) Is charcoal preferred at the home over other fuel sources? Why?
9) Where do you get your Charcoal from?
10) What is the main source of energy do you use for heating? And our there any other forms of alternative energy that is being used? Why? Or why not?
11) What livelihood activities take place within the community forest?
12) What is the community's greatest source of income?
13) After trees are cut down for livelihood activities does the community replant trees?
14) Are you satisfied with the current activities within your community forest or our there any livelihood activities you would like to see implemented into your community? Why?
15) What type of trees are used to make charcoal? Why are these trees preferred?
16) Where do you get the wood fuel from? Is payment required for the wood fuel?
17) How much wood do you need to produce a standard sack of charcoal?
18) What type of kiln is typically used to produce charcoal?
19) What is your roll in the charcoal trade? And how can the charcoal value chain improve?

APPENDIX 2: List and info of Interviewees

1) Interviewee#1 from Montserrado County. Urban Community Member. Date of interview: May/20/2019. Place of interview: ACDI/VOCA conference room

2) Interviewee#2 from Montserrado County. Urban Community Member. Date of interview: May/23/2019. Place of interview: ACDI/VOCA conference room

3) Interviewee#3 from Montserrado County. Urban Community Member. Date of interview: May/23/2019. Place of interview: ACDI/VOCA conference room

4) Interviewee#4 from Montserrado County. Urban Community Member. Date of interview: May/23/2019. Place of interview: ACDI/VOCA conference room

5) Interviewee #5 from Montserrado County. Urban Community Member. Date of interview: May/27/2019. Place of interview: ACDI/VOCA conference room

6) Interviewee #6 from Larvien Town. Community Forest Member. Date of interview: June/13/2019. Place of interview: Bleewehn, Grand Bassa County, Barconnie/Harmonsville CFMB Hub

7) Interviewee#7 from Bleewehn Town. Community Forest Member. Date of interview: June/13/2019. Place of interview: Bleewehn, Grand Bassa County, Barconnie/Harmonsville CFMB Hub

8) Interviewee#8 from Maffah Town. Community Forest Member. Date of interview: June/13/2019. Place of interview: Bleewehn, Grand Bassa County, Barconnie/Harmonsville CFMB Hub

9) Interviewee#9 from Deahplay Town. Charcoal Worker. Date of interview: June/14/2019. Place of interview: Bleewehn, Grand Bassa County, Barconnie/Harmonsville CFMB Hub

10) Interviewee#10 from Deahplay Town. Community forest Member. Date of interview: June/14/2019. Place of interview: Bleewehn, Grand Bassa County, Barconnie/Harmonsville CFMB Hub

11) Interviewee#11 from Zordah Town. Charcoal Worker. Date of interview: June/14/2019. Place of interview: Bleewehn, Grand Bassa County, Barconnie/Harmonsville CFMB Hub

12) Interviewee#12 from Penneh Town. Charcoal Worker. Date of interview: June/15/2019. Place of interview: Bleewehn, Grand Bassa County, Barconnie/Harmonsville CFMB Hub

13) Interviewee#13 from Madehgou Town. Community Forest Member. Date of interview: June/15/2019. Place of interview: Bleewehn, Grand Bassa County, Barconnie/Harmonsville CFMB Hub

14) Interviewee#14 from Bleewehn Town. Charcoal Worker. Date of interview: June/28/2019. Place of interview: Bleewehn, Grand Bassa County. Barconnie/Harmonsville CFMB Hub

15) Interviewee#15 from Zehyou Town Community Forest Member. Date of interview: June/28/2019. Place of interview: Bleewehn, Grand Bassa County. Barconnie/Harmonsville CFMB Hub

16) Interview#16 from Margibi County. Urban Community Member. Date of interview: June/24/2019. Place of interview: ACDI/VOCA conference room

17) Interview#17 from Montserrado County. Urban Community Member. Date of interview: June/26/2019. Place of interview: ACDI/VOCA conference room

18) Interview#18 from Monstserrado County. Urban Community Member. Date of interview: June/26/2019. Place of interview: ACDI/VOCA conference room

19) Interview#19 from Montserrado County. Urban Community Member. Date of interview: June/26/2019. Place of interview: ACDI/VOCA conference room