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Master's thesis

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Charcoal's contribution to rural income

- A livelihood study from Brong-Ahafo region, Ghana

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Abstract

The production of charcoal is an important income generating activity for many rural people in developing countries including Ghana where this study takes place. However, little is known about households' economic dependence on charcoal production and trade in the country. This identified knowledge gab in literature has led to the formation of this study that seeks to estimate the economic importance of charcoal income for rural people and to identify the variables influencing the dependence on charcoal income. The study applies the livelihood framework as a guiding tool in order to ensure that relevant variables are included in the survey. Further central to the study is a questionnaire developed with inspiration from the PEN Prototype Questionnaire which primarily is used as an instrument for collecting information about households' income but also addresses demographic and other contextual information about villagers. Data collection was performed in the center of Ghana, in Brong-Ahafo region, where 400 households were interviewed in 10 villages.

The findings show that with ~63% of respondents engaged in charcoal production, accounting for 12.5% of households' income, charcoal production is an important and commonly practiced income generating activity amongst households. Charcoal is primarily an important source of cash income (25% of total cash income), only surpassed by crop production which remains the dominant cash (and subsistence) income source. Generally, households with charcoal income are headed by married, younger males more likely not to belong to the dominant tribe in village compared to households with no charcoal income. Even though charcoal income generating activities are practiced across all income groups, there is some correlation between high total income and high charcoal income. Moreover, results show that a smaller group of households specializes in charcoal business and production and has high income as a result. Furthermore, households with charcoal business income and households with high charcoal production income are more likely to be members of a charcoal user group than other households, and households with high charcoal production income are also more likely to sell their charcoal outside the village than low charcoal income producers. In spite of the differences between charcoal income, charcoal remains a major job creator and income source in the study sites.

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1 Introduction

Historically, wood has played a central role as material for energy supply worldwide. In some parts of the world, mainly in industrialized countries, wood has now lost in significance as fuel and has been replaced by other fuels like gas, oil, and electricity which are considered more convenient and efficient. However, in many developing countries, wood fuel is still a major energy source (Arnold, Kohlin, Persson, & Shepherd, 2003). In this context charcoal, which is carbonized wood, is interesting because of its growing importance. The increasing popularity of charcoal is especially pronounced in Africa where production increased by around 30% from 2004 to 2009 (Aabeyir, Adu-Bredu, Agyare & Weir, 2016). Urban areas across sub-Saharan Africa are driving the increasing demand, and according to Zulu & Richardson (2013) around 80% of these urban households primarily use charcoal as fuel when cooking. Furthermore, the high demand is estimated to increase in the future, since urban populations are growing in size (Aabeyir et al., 2016). The popularity of charcoal can be explained by the many advantages of its use (regarding energy content, transportation and air pollution) compared to firewood. Another aspect of charcoals' importance is the fact that the high demand results in employment for many rural people in sub-Saharan Africa with market access to urban areas (Zulu & Richardson, 2013). This makes charcoal an important environmental income source relevant to investigate.

This study examines the charcoal sector's contributions to rural households' income in a charcoal producing area in Ghana. Like in other African countries, an increase in energy demand has been observed in Ghana in recent years due to a growing population size and urbanization. Especially charcoal consumption has risen, and from 2004 to 2008 the consumption rose from 752,000 tonnes to 1,48 million tonnes (Duku, Gu, & Hagan, 2011). Furthermore, charcoal consumption is relatively high in the country compared to elsewhere in West Africa (Anang, Akuriba, & Alerigesane, 2011), and Ghana is among the top ten charcoal producing countries in the world (Aabeyir et al., 2016). Ghana is therefore a relevant country to study charcoal production's importance to rural households' income.

1.1 Literature review

Prior to this study, several studies have been focusing on households' income from environmental resources. With data gathered in Zimbabwe, Cavendish (2000) was one of the first who, in a systematic way, estimated how much rural households earn from extracting environmental resources. He concluded that income from environmental resources contributed significantly to people's livelihood (35% of total income). Moreover, reliance on environmental resources was found to be higher for more poor people, while the absolute income from environmental resources increased with increasing income. Results from more geographically extensive studies in developing countries e.g. Vedeld, Angelsen, Bojö, Sjaastad, & Berg (2007) and Angelsen et al. (2014) are found to support these correlations. Based on studies in 24 developing countries, including Ghana, the PEN-project (Poverty Environment Network) has estimated people's environmental income in areas either close to a forest or in a forest to be 28% of their total income (Angelsen et al., 2014).

While there is a general agreement that wood fuel has an important contribution to many livelihoods, little attention has been paid to quantify this contribution (Schure, Levang, & Wiersum, 2014). The PEN-study did though, on a global level, estimate wood fuel (including charcoal) to account for approximately 35% of the income derived from forests. This figure accounts for only 7.8% of the total household income of which charcoal was estimated to make up about 11% (Angelsen et al., 2014). To this should be added the non-forest environmental income from wood fuel. Here wood fuels account for 20.6% of non-forest environmental income of which charcoal makes up 5.3%. Non-forest environmental income is though found to account for a much smaller share of total income (6.4%) compared to forest derived income (21.8%). The PEN study also estimates charcoal income from Latin America, Asia, and Africa separately. Even though the income share is slightly higher for Africa, it does not differ considerably from the overall global picture. Pouliot and Treue (2013), who contributed with data to the PEN-study from Burkina Faso and Ghana, also find environmental reliance to be considerable. Interestingly, they discover that with 30% of the total income, non-forest environmental products are particularly important for poorer people in Ghana. Having an isolated look at the income shares in one of the studied regions, Brong-Ahafo (same region as the present study), the two most important income sources are environmental

income and crop income (Hansen, Pouliot, Marfo, Obiri, & Treue, 2015). For the households in the poorest income quartile these are found to be ~33% and ~28% respectively, making environmental products slightly more important than agricultural products. The households in the richest income quartile on the other hand, have a considerably higher income share from crop production (~74%) and a smaller share from environmental products (~14%). Furthermore, livestock is found to be the third most important income source for the poorest households (~17%), while found to be of minor importance to the rich households (~3%). However, this study does not reveal the separate contribution of charcoal production to people's income, since this income is grouped under the category *other products income* of which the income share varies amongst income quartiles. The highest share of the *other products income* is though found for the richest households, while the lowest income share is found for the poorest which is ~17% and ~5% respectively (Hansen et al., 2015).

Charcoal producers have been grouped in two types: first, farmers who are only occasionally producing charcoal in order to supplement income from farming activities and secondly, commercial large scale producers who rely on the production as their main source of income (Obiri, Nunoo, Obeng, Owusu, & Marfo, 2014). A study by Agyeman, Amponsah, Braimah, & Lurumuah (2012) estimates incomes of commercial charcoal producers and charcoal buyers in the Upper West region of Ghana to be around GH¢ 200 and GH¢ 82 – 2343 respectively per month. Noteworthy is that the producers in this study, dominated by the Sissala ethnic group, were found to have a considerably higher income than the mean income in the region (almost four times as high). Even though this indicates that charcoal production can result in relatively high incomes, findings show that marketers and transporters have higher profits (Obiri et al., 2014). Furthermore, the charcoal byers' income presented by Agyeman et al. (2012) varies considerably with some buyers earning quite high amounts on their business. However, these results do not say anything about the economic dependence of charcoal production among the broader population in the study sites, since the target population only includes commercial producers and not non-producers. Furthermore, it remains unclear how exactly commercial producers are defined in the study. However, since the selection of producers is based on a list of commercial charcoal producers acquired by The Forestry Commission and their production is between 20.1 and 20.5 bags per month

there is an indication that they are large scale producers. The results do thus not say anything about the economic importance of charcoal production for small scale producers. Moreover, there is no information about whether the commercial producers and buyers have other incomes beside charcoal production and trade. This leaves us with limited information about households' income share from charcoal production in Ghana.

There is however studies outside Ghana that can give more detailed insights in dependence on charcoal income in rural communities. In a study from Uganda, charcoal producers were found to have significantly higher incomes compared to non-producers, and the study further shows that charcoal income (both in absolute and relative terms) increases with total income amongst producers (Khundi, Jagger, Shively, & Sserunkuuma, 2011). The study also found that households engaging in charcoal production have lower income shares from crop production as well as from livestock and that charcoal producers were found to own less valuable productive assets. Additionally, proximity to roads and forests showed to influence the rate of participation in charcoal production. Moving west of Uganda, to DR Congo, a study by Schure et al. (2014) finds that the income of charcoal producers in one of the studied regions was above the provincial average income. This thereby supports the above mentioned findings from Ghana and Uganda. However, as Schure et al. (2014) also point out, these findings might largely be explained by bigger household sizes and closeness to urban markets. Furthermore, the study found that even though charcoal's share of total income can differ greatly according to geographic placement, charcoal contributes with a considerable share of households' income in charcoal producing areas. The income share from charcoal production was found to be as high as 75% in one study site and 38% in the other, yet it remains somewhat unclear how exactly the total incomes of producers were calculated. This study also investigated what charcoal producers found as being important income-generating activities. Here agriculture was mentioned by most producers as being of great importance. Activities like trading in small commodities along with timber extraction was also considered rather important. NTFP (Non Timber Forest Products) collection, hunting, fishing and livestock, though found to be important, varied much in scores according to study site. These findings do however not present charcoal producers' actual income share from the mentioned activities. Moreover, it does not provide any in-

formation about possible differences in those income shares for producers and non-producers respectively. However, the average volume of production amongst producers was found to be higher for high income groups. Furthermore, compared to fuelwood net profits are found to be higher for charcoal and the labor return is likewise relatively high, also being higher than the average regional income.

Even though the studies presented above suggest that households engaged in charcoal production are amongst more well of households, this is different from the common picture of charcoal producers. According to Jones, Ryan, & Fisher (2016) the literature generally describes charcoal producers as poor people with little agricultural capacity, mainly young males lacking alternative income sources and being dependent on charcoal as a safety net (e.g. Bekele & Girmay 2013). Much literature further picture charcoal producers as poorly educated (Mugo & Ong, 2006; Bekele & Girmay, 2013; Obiri et al. 2014).

The age of charcoal producers are presented in some Ghanaian studies. According to Obiri et al. (2014) charcoal producers were on average found to be 35 years old, while the mentioned study by Agyeman et al. (2012) finds 73% of charcoal producers to be 20 – 49 years old, and Anang et al. (2011) find 90% of producers being 21 - 40 years old. This thus supports the assumption that charcoal production mainly attracts younger people. Regarding the sex of charcoal producers, the share of producers being male varies amongst studies. Obiri et al. (2014) record ~88% of producers as male, Agyeman et al. (2012) finds 66% being men, while the study by Schure et al. (2014) finds a higher share (only 3.4 - 4.9% were found to be female producers) in DR Congo. However, in some places, women are also found to be the dominating sex of producers (Anang et al., 2011), and it is argued that women's engagement in charcoal production can give them financial autonomy (Jones et al., 2016). When it comes to the economic aspects of charcoal, several sources describe how this income source influences people's livelihoods. According to Anang et al. (2011) many of the people engaged in charcoal production state that they will starve as a consequence of a ban on charcoal production. According to the respondents of the same study, a ban will also result in more children dropping out of school along with a lack of means to buy things like clothes. Other sources also support that money from the production is invested in things like school fees for chil-

dren, medicinal care, and agriculture (Obiri et al., 2014; Schure et al. 2014). Zulu & Richardson (2013) further argue that many poorer people are engaged in the charcoal production and trade, and that it contributes with important income in the off-season, thereby making the charcoal trade an economic safety-net for many. These findings are in line with the roles environmental resources normally play for rural people. According to Angelsen et.al (2014) these roles are defined by the literature as being:

> *(i) supporting current consumption, (ii) providing safety-nets in response to shocks and gap-filling of seasonal shortfalls, and (iii) providing means to accumulate assets and providing a pathway out of poverty* (p. 13)

Even though there is a preference for modern sources of energy among the charcoal producers themselves, most of them use firewood, which is often easily available and a cheaper solution compared to charcoal. Therefore producers do not see charcoal as an affordable option for own consumption but rather as a mean to earn cash (Anang et al., 2011). Furthermore, charcoal producers have been described as a marginalized group of people who are badly understood and who do not have much influence on policy decisions (DEAR, 2005).

According to DEAR (2005), there is a widespread assumption that charcoal production is harmful to the environment. Furthermore, they state that people who engage in the production often are pictured as irresponsible people who cut down trees indiscriminately because of the prospects of making quick and easy money instead of producing food through farming activities. These assumptions, said to be promoted especially by politicians, has been challenged by DEAR who argues that there is a lack of solid evidence that charcoal production leads to deforestation and environmental degradation. Arnold, Köhlin, & Persson (2006) also point out the fact that there are other factors than demand for wood fuels that can lead to deforestation, including a high demand for agricultural land in peri-urban areas. DEAR further argues that people engage in charcoal production because of need rather than joy due to increasing risks associated with farming activities. Moreover, charcoal production is a part of a shifting cultivation practice, thus most of the wood for charcoal production is fetched from people's own fallow land and not from regular forest areas.

1.2 Problem analysis and statement

Based on the literature review it can be concluded that there is limited information available about who benefits from the charcoal sector and its importance for rural people. Extensive studies have been made about dependence on environmental income, but these studies do only reveal little useful information about the income share from charcoal production. There are however studies focusing on charcoal income, but these studies are few and do not present detailed information about how charcoal affects households' total income as well as the distribution of income sources, especially not in a Ghanaian context. Filling out this identified knowledge gab is going to shed light on an environmental resource which has been neglected in many studies of environmental resource dependence. Proper data about charcoal production's importance in Ghana can further make way for sustainable political initiatives and regulations of the charcoal sector - something that can be expected not to be less relevant in the future since the demand on charcoal is increasing. The present study will contribute with such information and thereby facilitate that politics can be based on empirical data.

1.3 Objectives

The overall objectives are to broaden the knowledge about the economic importance of charcoal production for rural people. The knowledge obtained is further a link to better understanding how benefits are distributed in the charcoal value chain. Finally, the knowledge should help facilitate the formation of policies that are both sustainable and that consider the people dependent on the production. The specific objectives are:

1. To estimate the economic dependence on charcoal in a charcoal producing area both in relative and absolute terms
2. and to identify the variables influencing the dependence on charcoal income.

2 Theory and conceptual framework

Analyzing rural livelihoods in a developing country can be challenging because households and household strategies are complex in nature. Often people have several income sources derived from a wide range of activities of which farming is just one (Ellis, 2000). The livelihood framework is useful because it helps you dealing with this complexity by providing a checklist of important aspects to include (Ellis, 2000; Scoones, 2015).

Ellis (2000) presents five capitals of the livelihood framework (natural, physical, financial, human, and social) that can be accessed by households. These are the basic assets that form peoples livelihood strategies and that people are dependent on for survival. In short, *natural capital* like water, land and biological resources must be accessible for people dependent on e.g. hunting, gathering or farming. *Physical capital,* e.g. roads, machines, and electricity, are man-made capitals, often seen together with industrialization and urbanization. *Human capital* both refers to the education level of people, the skills they possess, and their health status. These are all determinants of the amount and quality of the labor available. *Financial capital* refers to savings in the form of money, livestock, gold etc. and the access to credit (loans). Finally, *social capital* is defined by social groups, reciprocity, personal or family network, and inclusion in society. Social capital can thus be seen as an investment of time and resources in nurturing networks which then later can provide households with livelihood security.

The five capitals, also called building blocks of livelihoods, are essential for people's survival capabilities, but there are however also other factors that influence peoples livelihood strategies. First of all there are the *mediating factors* which need to be analyzed in order to identify opportunities and constraints for people's utilization of their capitals (Ellis, 2000). These include *social relations* (e.g. gender, age and ethnicity), *institutions* (e.g. rules, customs and land tenure) and *organizations* (associations, state agencies, NGO's etc.). Furthermore, *trends* and *shocks* are contextual factors that affect people's livelihood strategies (Ellis, 2000). Trends are for example population growth, agricultural technology, outmigration, economic development, and macro politics. Unforeseen shocks can both course challenges to individual persons and populations. Indi-

vidual shocks can be accidents, death or loss of land rights, and population shocks can be civil war, drought or pest outbreaks. All these listed risk factors make a vulnerable setting for rural people. In order to create a secure livelihood it is therefore often necessary to be able to substitute between assets (Ellis, 2000).

Several issues have been pointed out and criticized about the framework (Scoones, 2015). Some issues concern a presentation of the five capitals in a diagrammatic pentagon where the argument is that the capitals cannot be compared. Others criticize some of the definitions and terms used. Especially social capital can be challenging to measure since analysis on reciprocity and personal networks often requires a more thorough qualitative approach (Ellis, 2000). The limited number of capitals has also been accused of resulting in flaws. An argument is here that cultural and political capitals should be included in the framework as well (Scoones, 2015). Cultural and political aspects can though be considered mediating factors or part of the social capital, and despite the criticism, the livelihood framework is still regarded as a good tool in analyzing rural people's resources and challenges. Furthermore, Scoones (2015) stresses that the framework does not provide a complete description of reality, but should merely be used as a guide in how to structure the complexity of rural livelihoods.

The livelihood framework will in this study be used as a checklist ensuring that important aspects of rural livelihoods will be included in the household survey. It will also serve as a model that helps explain relations and in that way be guiding the analysis. By including questions about households' assets an asset status can be made on charcoal producers. In this way potential asset poverty can be identified amongst charcoal producers. Mediating factors and contextual factors will also be included where possible for creating a better understanding of charcoal producers' options and vulnerability to changes. Restrictions in charcoal production might result in a decreased access to natural capital, and by knowing what other capitals households have access to as well as their asset substitution options it is easier to create suitable politics that can either help people strengthen their assets or help them get access to other assets.

3 Methods

This chapter explains how and under which conditions the present study was conducted. It also includes relevant considerations regarding the use of methods primarily related to household interviews and the preparations connected with these. Additionally, the use of focus group meetings and supplementary semi-structured interviews is presented. Finally, the chapter ends with a description of how data processing has been done.

3.1 Methodological considerations

Central to the study is a questionnaire which has been developed with a prototype-questionnaire made as a part of the PEN-project as a model. The PEN Prototype Questionnaire (CIFOR, 2008) consists of several surveys both on village level and on household level where quarterly surveys are made. Due to a shorter fieldwork period, the procedure used in the PEN-project could not be adopted in this study. Instead of a recall period of three months this study uses a recall period of one year. The reason for choosing this recall period is that seasonal variation is likely to affect changes in income and income sources. By having a recall period of a whole year (instead of e.g. one month or one quarter of a year), these changes can be registered in the survey.

A structured survey was chosen as the main data collection instrument of this study because the gathered data needed to be quantified and compared within a rather large sample size. The scope of the study highlights the importance of structuring and coding data. Furthermore, a structured survey can provide data at relatively low costs compared to e.g. participant observation (Cundill, Shackleton, & Larsen, 2011). The sample size of this study (400 households) is chosen because a larger sample makes it possible to carry out a more extensive analysis with less risk of sampling error (Shively, 2011).

3.2 Household survey

The household survey was formed on the basis of structured interviews with household members with the use of a questionnaire which was filled out during the interview. The questionnaire was made beforehand and was tested and adjusted in the field before the actual data collection started. Visits to each of the villages included in the study were also made before the survey begun in order to get permission to work in the villages and make the necessary arrangements. The interviews were done by enumerators in the local

language, Twi, and the answers were registered on tablets. Each interview normally lasted more than one hour depending on the number of income-generating activities of the household. The unit of analysis, a household, was defined like in the earlier mentioned PEN study:

> *A household is defined as a group of people (normally family members) living under the same roof, and pooling resources (labour and income). Labour pooling means that household members exchange labour time without any payment, e.g., on the farm. Income pooling means that they "eat from the same pot", although some income may be kept by the household member who earns it*. (CIFOR, 2007, p. 21).

3.2.1 Sampling strategy

Meeting the required presence of charcoal production, Brong-Ahafo was chosen as the region of interest. The target population was all people living within the selected study sites, where a total of 400 household were interviewed within two months (February 10th – April 1th 2017). For smaller villages the aim was to conduct 30 interviews, while the aim for larger villages was around 50 (see Table 1 for actual number of interviews in each village). The selection of study sites was primarily based on gathered information about the presence of charcoal production, ethnic background of community members, and remoteness of villages (different ethnicities and degrees of remoteness should be represented in the survey).

In order to make sure that different characteristics within the target population were captured in the sample, there was an aim of a stratified-random sampling strategy. However, because no household lists existed in the selected villages it was not possible to follow the optimal sampling procedure where households with a certain interval are chosen on a list. The geographic placement/formation of houses (not on straight rows) also made it challenging to systemize sampling. Moreover, the fact that many people were not at home at the time of the interviews also made simple random sampling difficult. Precautions had though been taken in order to minimize the issue of empty houses. This includes doing interviews in the villages both in the early morning with the hope to catch people before going to farm and again in the afternoon/evening. Before sampling begun in each village, the village was divided into different areas, and each enumerator

was assigned to work within one of them. This was done in order to prevent enumerators from working in the same parts of a village and thereby reduce the risk of asking the same people twice to participate in the survey. Whenever possible, when making geographic divisions, it was taken into consideration which ethnic groups were situated where in order not only to get one segment of people in a village. After pilot-testing the questionnaire, it was decided that, as a rule of thumb, not only the household head but also the spouse should be present at the time of the interview. This decision was made due to men's lack of knowledge about the female contribution to household incomes, such as gathering of some environmental products, growing of vegetables for subsistence need, and some types of businesses. Interviewing more than one person in a household was especially important for large households, since one person often was not able to give records of all the income generating activities in the household.

3.2.2 Valuation methods and variables of interest

The survey includes several variables and potential factors influencing dependence on charcoal income. Overall, the questionnaire can be divided into two parts; the first part gathers village-level information (Appendix A), while the second part only addresses questions regarding individual households (Appendix B). The variables investigated at village-level include categories like geography, climate, demographics, and infrastructure, whereas the household survey includes variables related to household composition, characteristics of household, assets, and income.

In order to get the full picture of how big a share charcoal income is out of the total income, both cash income and subsistence income has been measured. Furthermore, costs of inputs has been identified and subtracted from the gross income in order to reach the net income. Data about inputs like for instance fertilizer, transport, and labor (though excluding family labor) was therefore collected. Subsistence income might include non-marketed products which can be substantial especially in more isolated areas (Wunder, Luckert, & Smith-Hall, 2011). In this survey, local-level prices were used in most cases, since most products were marketed. Yet, for some unprocessed environmental products, like for instance wild leaves, there was no known price. For such non- marketed products the intention was to base the product values on the respondent's WTP (Willingness To Pay) (Wunder et al., 2011). However, the WTP procedure was found to be difficult

to use by the enumerators who complained that the respondents in many cases were unable to answer such questions. Because of this, the team decided to agree on more fixed prices (determined by enumerators on the basis of local estimations) for products such as leaves, mushrooms, and medicinal plants. During a market visit towards the end of the survey the team though realized that the price for leaves had been put too high. After all data were gathered, the incomes from leaves were therefore changed to a lower value.

Another issue taken into account was that in some cases respondents were still storing crops produced in 2016 when the interviews were held. In such cases the stored crop was recorded under subsistence income, and the current price of the product was used when valuing the product. Furthermore, some households had higher costs than earnings within one income category. In such cases, mostly observed for crop production when households have had a crop failure, the negative income was recorded along with positive incomes. However, larger new investments such as establishment of cashew plantations were not recorded, since registration of huge costs associated with such an investment would make a household seem very poor.

Finally, information given by villagers was triangulated by observation whenever possible e.g. by observing people cooking, assets owned by households, products sold on markets, and crops grown on fields.

3.2.3 Enumerators, risks and ethical considerations

Because of limited time to carry out the study it was decided that four enumerators should be hired to collect data. Three men and one woman residing in Kintampo close to the study sites were thus recommended by the local Forestry Commission to carry out the job, and they were subsequently hired by the project (a more detailed description of the study area is found in chapter 4). Thus, five people in total were conducting the household interviews, the fifth person being PhD student Lawrence Brobbey.

There are several things one has to be aware of that can have negative influence on the quality of data collected. Lund, Shackleton, and Luckert (2011) list several systematic measurement errors related to how enumerators and respondents tackle an interview. Since this project hired a team of enumerators to interview the households in the sam-

ple, many of these potential errors are important to have in mind. First of all, the integrity of the enumerator is essential in order to get quality data. Some enumerators might do short cuts or even falsify data. This is of course unacceptable and must be prevented. Laziness can be a cause, but unclear instructions and misunderstandings of the collection method can also be reasons. There has therefore been focus on motivating the enumerators, making sure that they understood their task, and were aware of possible pitfalls. Furthermore, the enumerators were informed that there would be data checking of all interviews, and that they would be asked questions regarding a respondent's answers if anything recorded seemed unclear. Data checking also included focus on systematic differences in results and suspiciously similar or random numbers. Additionally, my presence in the field and engagement in the interviews was also supposed to motivate the enumerators and prevent them from doing short cuts.

When collecting data for a household survey, there is a risk that respondents might not be willing to spend enough time on an interview (Lund et al., 2011). They might be busy with other things and therefore refuse to help you or rush through the questionnaire. This issue was sought mitigated by acquiring information about when people were most likely to be available for interviews. This was done prior to the interviews and the responses were taken into consideration when planning which days of the week and times of the day interviewing should take place. Additionally, enumerators were encouraged to schedule with selected households which time would be more suitable for the respondent. The risk related to lack of willingness to participate has however not been considered severe in this study because the interviews have been carried out in the dry season and thereby not in a period where farmers are most busy. However, enumerators have often had difficulties finding respondents to interview, since people often were not in or around their houses. In such cases enumerators had to interview the households present at the particular time.

In a study like this there are several ethical considerations and potential risks that need to be addressed in order to promote villagers honesty and willingness to participate in the project. First of all, villagers might hesitate to participate or be reluctant with sharing information if they think you have a hidden agenda (Reyes-Garcia & Sunderlin, 2011). To avoid this risk, the enumerators were told to put an effort in explaining the

purpose of the study and who we are before starting an interview. According to Reyes-Garcia and Sunderlin (2011), elaborations should also be made regarding how the study might affect the involved villagers' lives. The enumerators were thus trained in explaining respondents that they should not expect any direct benefit from the study. Potential effects of the study were instead phrased as being more indirect, since the findings can influence future policy making. Shively (2011) likewise stresses that it is a good idea to make the selection of households for the sampling transparent so that villagers will not feel that they are distinguished between. Hence the enumerators were told to explain villagers that the selection of households were to be done randomly and that they should not feel offended if not asked to participate. Another thing worth remembering is that income can be considered a sensitive issue for some people which is why privacy of participants was protected and confidentiality assured to the respondents. Making sure that these issues are addressed is likely to improve the quality of data gathered, since people then will be more honest and less reluctant in their answers (Reyes-Garcia & Sunderlin, 2011). Furthermore, it should be mentioned that a prior and informed consent to participate in the survey was acquired from the respondent before any interview took place. This means that if for some reason a household did not wish to participate then this choice was accepted. As a way of thanking the involved villagers, each participating household was given two pieces of soap which they generally seemed very happy to receive.

3.2.4 The use of "ODK Collect"

In order to reduce data entering time and potential risks connected with the use of paper version questionnaires, such as missing loose sheets and unreadable hand writing, information acquired during interviews were entered on tablets. Each enumerator was given a personal tablet along with a notebook in which calculations and additional comments regarding each household was to be made. The use of tablets required a digitalizing of the household questionnaire. This was done in EXCEL by the use of an XLSForm design, as described on opendatakit.org, which was then later converted to an XForm, which can be read by ODK Collect. ODK Collect is an app designed for digitalising questionnaires, and it was installed and used on the tablets for the household survey. In order to make sure that enumerators were properly trained in how to use the app, time was set aside in the beginning of the field work period for this purpose. This pre-

survey training lasted for three days and included an introduction to the project, guidance in the use of tablets, and interview trials in non-selected study sites. Data checking was done for all completed interviews in the selected study sites. When digitalizing the questionnaire using the XLSForm design, the making of a "constraint" column facilitated that restrictions could be made on the entered information. This was done in order to avoid typing mistakes or careless entering of information on tablets. Limits were thus made for what was considered reasonable answers. For instance, when entering number of members in a household the number of members in each of the defined age groups could not exceed the total number of members in a household, and adding together the recorded members of the age groups had to equal the total number of members recorded. The same principal was used throughout the interview when asking about sold amounts and subsistence amounts of products which added together had to equal the stated total amount of a given good. Taking measures like this thus helped ensuring quality data.

When an interview was qualified as okay, it was uploaded on a server. To be able to do this, ODK Aggregate had to be installed on a computer prior upload of interviews. This includes the creation of a Google Cloud Platform account following the guidance found on opendatakit.org. Data checking and upload was usually done every night after ending field work, if not postponed due to practical obstacles like lack of time or internet connection.

3.3 Focus group meetings

Before starting any interviews in a village a focus group meeting was arranged in order to get necessary village level information (Appendix C). Three Participatory Rural Appraisal (PRA) methods were used in each focus group meeting: ranking, seasonal calendar and participatory mapping. It was strived to form a representative group of approximately 10 people in each community, people comprising both young, old, rich, poor, men, and women. The representatives were selected in collaboration with the Chiefs and/or other opinion leaders. The idea behind this was to ensure that the perspectives shared at these meetings were representative for the villages and thus avoiding that only a certain group of people in the village was heard. Furthermore, the ideal was to get 50% women when holding these meetings. However, this was not possible due to the

missing tradition for women's participation in meetings in the study sites which resulted in an underrepresentation of women to the focus group meetings. Regarding the number of participants there were also sometimes fewer or more people than wished for. During each focus group meeting a minimum of one enumerator was present to help assist with the PRA exercises and to take notes about the issues and discussions brought up at the meeting. After each session the remaining enumerators were briefed on important findings from the meeting such as information about ethnic groups, gathered and produced products, and user groups in the village.

3.3.1 Ranking

After introducing the project and explaining the purpose of the study the participants were asked first to list the unprocessed environmental products collected, then the processed environmental products and finally the farm products/crops cultivated in the village. Each participant was then given five stones and asked to distribute his/her stones on the products of most importance for him/her (Figure 1). So if for instance one person gets all income from a certain crop, he could place all his stones on that crop. The environmental and agricultural products receiving the highest numbers of stones were considered the most important products in the community.

Figure 1: *Ranking exercise during focus group meeting*

Apart from forming the basis of the next exercise (seasonal calendar), the ranking exercise was used to make sure that all important products gathered and produced in the village were addressed in the household survey.

3.3.2 Seasonal calendar

The seasonal calendar was done immediately after the ranking exercise. The seasonal calendar was drawn on a large piece of paper and consisted of columns for each month of a year and rows addressing activities of the villagers (Figure 2). Originally the intention was to make a seasonal calendar of environmental product gathering, agricultural activities, and other seasonal employment opportunities in every village. Due to time constraints it was though decided that a seasonal calendar for only the most important agricultural products was to be made. However, questions regarding seasonal employment opportunities such as migration work along with information about seasonality in charcoal production were still addressed in every village. The seasonal calendar along with the discussion of seasonality of charcoal production and other employment opportunities thus provided an indication of the seasonal importance of both farm and off-farm activities taking place in the study sites throughout the year.

3.3.3 Participatory Mapping

The last PRA exercise in the focus group meetings was a participatory or resource map of the village (Figure 3). The purpose of this was to get an overview of the land use, vegetation, and infrastructure development in each community. This activity thus provided important contextual information and was also used for verifying gathered information about major income generating products harvested by the villagers. The participants were asked to draw the map themselves which normally resulted in selection of one person who were to draw the map with assistance from the crowd. The map included things like roads, streams/rivers, clusters of houses, important buildings (schools, health clinics etc.), farm lands, plantations, lakes, forests and cemeteries.

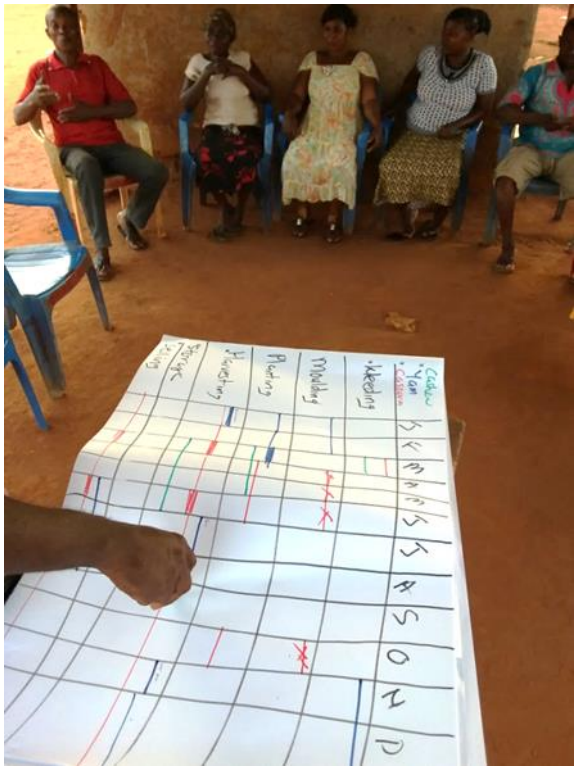

Figure 2: *Seasonal calendar exercise*

Figure 3: *Participatory mapping exercise*

3.4 Semi-structured interviews

Whenever possible a small semi-structured interview was held after the focus group meeting (Appendix D). The purpose of the interviews was to get additional background information about customary rules and land/tree tenure. The issues addressed during these interviews thus primarily contribute with information about mediating factors related to institutions regulating the access to natural capital. Amongst the respondents interviewed are village chiefs, district assembly and unit committee members, and a few regular farmers.

3.5 Data processing

After data collection all household information was downloaded from Aggregate and managed in the statistical software package StataIC version 14. The following sections presents what measures have been applied to detect mistakes in the dataset and how incomes have been calculated and analysed.

3.5.1 Data cleaning

Before the actual data analysis could begin "data cleaning" was necessary in order to identify typing errors and other possible mistakes in the dataset. This was done by making a list of outliers, i.e. a list of atypical high or low numbers in the dataset. Products were first sorted into groups according to type of product and unit of measurement and then the outliers were found for groups where more than 10 observations were recorded. This was done by using the summarize function in Stata and the formula: mean + 3* standard deviation and mean -3* standard deviation. It was considered unnecessary to look for outliers for total amounts of products and net income since the former is the sum of sold and subsistence use and the latter is the sum of gross income and costs. Total amounts and net income should therefore be reflected in outliers found in the included categories. After finalizing the outlier list, the outliers were double checked and when necessary enumerators were contacted to confirm recordings. Corrections were subsequently made in the data based on the identified errors. Outliers not identified as errors were left unchanged in the dataset.

3.5.2 Calculating income

Total annual net incomes have been computed in Stata and converted to US$ using the 2016 exchange rate of 3.992 (CIA, 2017). Furthermore, incomes were adjusted to the number of individuals in each household in order to take the size of households into consideration when comparing incomes between households. This has been done by the use of OECD's equivalent scale where the first adult in the household gets the value 1, additional adults get the value 0.7 and household members under 15 years get the value 0.5 (OECD, 2005). From now on this will be referred to as aeu (adult equivalence units).

The relative income for each income source is based on the mean of individual households' income share. According to Pouliot & Treue (2013, p. 186) this procedure can "*…reduce the influence of extreme individual household values…".* Absolute values are also presented. These are based on the average of shares stated and the average total income by group. The absolute value is hence not the average absolute income for each source. In order to give a general picture of dependence on charcoal income compared to other income sources, the average income shares are found for all sampled house-

holds. Furthermore, households have been categorized in different groups. First, according to four income quartiles (Table 3) which are based on computed total net income ranked in size, and secondly, according to households' engagement in charcoal income generating activities (whether households have charcoal production/business income or not and, if they have charcoal production income, to what extend). The latter grouping forms the basis for the characterization of charcoal producers in section 5.2. Here the two categories *households with low charcoal production income* and *households with high charcoal production income* are based on total net income derived from charcoal production. Furthermore, the grouping of households into charcoal business income quartiles (Table 14) and charcoal income quartiles (Table 15) are based on households' total net incomes from charcoal business and total charcoal income (charcoal wage work, charcoal production, and charcoal business) respectively, ranked from lowest to highest income in equal sized groups.

In order to evaluate whether results are statistically significant, ANOVA F-tests along with Bonferroni's tests have been made when analysing correlations between independent categorical variables and continuous dependent variables. This has primarily been done when average income shares were found for different groups of households. When finding statistical significance for two categorical variables Chi-square tests have been made.

The calculation of cash and subsistence income shares were based on information about whether products were sold or used for own consumption. In the case where only costs and no positive income are registered for a product (e.g. a livestock or a type of crop) the negative net income has been divided equally on subsistence and cash income.

4 Study area and context

This chapter presents the context of the study. This includes a geographical description of the study sites as well as findings from focus group meetings and semi-structured interviews regarding access to trees including customary rules and land/tree tenure. Finally, based on results from the household survey, basic and socio-economic characteristics of villages are presented.

4.1 Geography and climate

Charcoal production is a widespread activity that takes place in all regions of Ghana (Obiri et al., 2014). However, there are some areas within the country where production is more concentrated. All 10 study sites are situated within one of the main charcoal producing regions, Brong-Ahafo (Obiri et al., 2014) (see Figure 4 - B), in the forest-savannah transition zone in the central part of Ghana. More specific the study sites are located between 7.7 – 8.5 N and 1.4 – 1.9 W in three districts: Kintampo North, Kintampo South and Nkoranza South, where village 5 and 6 are in Kintampo South, village 8, 9, 10 are in Nkoranza South, and the five remaining villages are in Kintampo North (see Figure 4 - A). The region experienced an annual population growth rate of 2.3% between 2000 and 2010, close to the national rate of 2.5%, and has a population density of 58.4 persons/km^2, which is considerably lower than the national average of 103.4 persons/km^2 (GSS, 2012). Brong-Ahafo region is known as a major food-producing area (Amanor, 2009), and inhabitants of the region are primarily farmers or engaged in agricultural related work (Government of Ghana, 2017). Regarding rainfall and vegetation the northern part of the region is generally drier and less forested than the southern part (Amanor, 2009). Kintampo (8.06 N, 1.72 W) had on average 1,115 mm of precipitation annually and an average temperature of 27.8 °C from 1991 to 2015 (World Bank, 2017). Furthermore, the region has a MPI (Multi-dimentional Poverty Index) incidence of 51.7%, with an estimated 12.1% of the population being in severe poverty, which is a little higher than the average national level, but somewhat lower than the three most northern regions of the country (GSS, 2013). Better climatic conditions along with abundance of farmland are important factors driving people from the northern regions to Brong-Ahafo, where an estimated quarter of the population originates from the north (Government of Ghana, 2017). The differences in development within the region can

also to some extend be explained by vegetation and climatic conditions, where the moist semi-deciduous forest characterising the south creates a better environment for cash crops such as cocoa and cashew compared to the guinea savannah woodland found in the north (Government of Ghana, 2017).

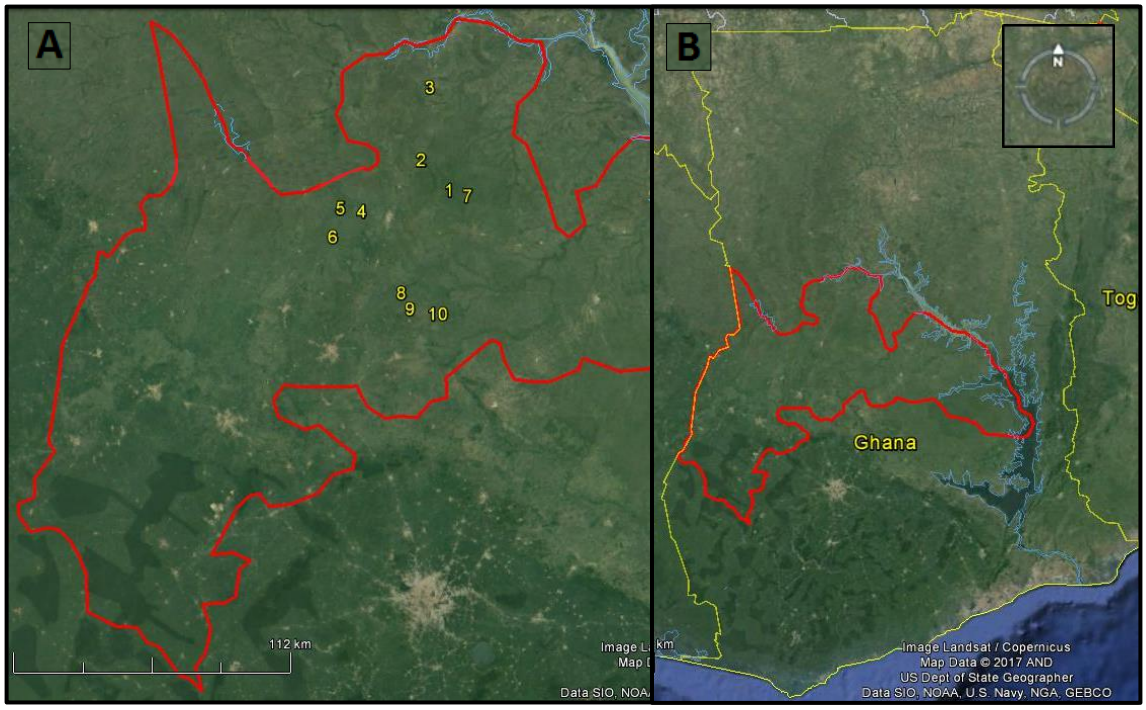

Figure 4: *Location of study sites*

Note: The area with red outline indicates Brong-Ahafo region, and the numbers in picture A indicate the study sites: 1. Kunsu, 2. Chiranda, 3. Gulumpe, 4. Asantekwa, 5. Sabule, 6. Mansie, 7. Miawani, 8. Bonte, 9. Bomini & 10. Dromankese.
Source: The maps are made in Google Earth based on GPS coordinates recorded during field work.

4.2 Access to trees

Discussions during the seasonal calendar exercise show that charcoal production fluctuates somewhat during a year, where production is higher in the wet season compared to the dry season. The reason for the high production in the wet season is that at this time of the year there is plenty of grass and soft soil which is needed when making the earth mound kiln used in the production. Additionally, villagers generally express that the hardest period of the year (when there is little food and income) is June – July, where conditions for making charcoal is good. In Asantekwa villagers told that at this time of the year people are busy weeding, and households can therefore not just focus on charcoal production even though production is easy in this period. Still, during the house-

hold survey, some households expressed that charcoal production is an important income source in this period of the year.

Generally, in all villages there are some rules regulating the harvest of trees. One of the common rules is that you are not allowed to fell commercial timber trees such as Mahogany, Odum, and Senya without permission. This permission is officially given to timber contractors by the Forestry Commission. You are also not allowed to fell Shea, Mango, Dawadawa and other tree species providing villagers with supplies of fruits/nuts and cash income. Some villagers also report that it is forbidden to fell small trees and trees that are still alive (in Bonte we were told that originally only dry wood from farm land was used for charcoal production). Furthermore, there are also areas where you are not allowed to fell any trees. This often applies to areas along river banks, around cemeteries and other places hold sacred for villagers. The villages Bomini and Bonte are located rather close to a forest area called Boabeng Fiema Monkey Sanctuary. All communities along the monkey sanctuary are protecting the area in conduction with The Wildlife Division of The Forestry Commission and the NGO Native Conservation Research Centre who are controlling that nobody is damaging the habitat of the monkeys. Here villagers expressed that they are not using wood from the sanctuary for the production of charcoal because it is a taboo to touch the trees as well as the monkeys in the area, and killing a monkey will cause a penalty. Even though there are some external organizations involved in the protection of the area, norms and customs are thus also regulating the access to trees.

Land and tree tenure is a complex matter and varies according to history and costmary rules in each village. Nonetheless, an attempt has here been made to understand some of the dynamics influencing land and tree tenure. Normally there are different rules for indigenous inhabitants and migrants. Regarding land tenure it is the common rule that migrants need to pay something in order to farm on a piece of land. The nature of this payment, how much and to whom, is different from place to place, but it often includes a permission from, and a payment to, the chief. In Bomini there is though no official rule of payments for land. Migrants are also likely to be denied income from tree plantations. The Sabule villagers told that migrants are only allowed to grow crops. Since it takes many years to grow trees, tree planting is seen as claiming ownership of the land

why this right is only reserved to the indigenous people. Regarding tree tenure amongst villages, individual migrants have to pay the largest known amount for trees in Bomini (50 out of 150 bags). Bonte, Dromankese and Gulumpe also have fixed prices for trees felled for charcoal production. In the two first mentioned villages migrants pay 20 out of 100 bags produced, while producers in Gulumpe (both migrants and indigenous) pay 15% of bags produced. However, women in Gulumpe were said to be excluded this rule, even though this was reported not always to be followed. In the remaining villages (except Asantekwa) migrants and/or full time producers have to pay for trees, but here the amount is not fixed. In Asantekwa producers used to pay for trees, but this has changed with the disappearance of larger trees, and now nobody is paying anything.

Regarding the availability of trees, all villages reported a decline which was not only restricted to trees but also most other environmental products. Especially one village, Asantekwa, reported a severe decline of trees. Even though this village has a community forest the villagers told that the availability of wood has become low. The villagers explained that the Sissala people originally started charcoal production in the village, but when the rest of the villagers found out that it was a good business they also engaged in the production. The popularity of charcoal production made villagers violate the customary rules which were supposed to protect certain tree species like for instance shea trees. This has thus resulted in a reduced income from shea nuts. The villagers further explained that the community used to produce much more charcoal but now produce very little because only few trees big enough for the production of charcoal are left. As a consequence villagers are now focusing more on farming like before they engaged in charcoal production.

4.3 Basic characteristics of villages and households

The population size of the villages varies from 409 in Chiranda to 6742 in Dromankese (Table 1). Looking at different aspects influencing the level of natural, physical as well as human capital, the following basic information has been recorded: All villages except Mansie have electricity. This does however not mean that all households have electricity but merely that the village is connected to the grid. All villages have access to water, but in some villages they reported to have shortages of water in some periods of the year because of dried out boreholes. This problem was said to be particularly severe in Chi-

randa, but also Gulumpe, Asantekwa, and Sabule informed about water shortage. The presence of health centers with nurse and midwife along with primary schools in villages also facilitates a basic level of human capital.

Table 1: *Basic characteristics of villages*

Village	Interviews (*n*)	Population[a]	Electricity	Bole hole water	Health center	School
Kunsu	30	1132	√	√	√	√
Chiranda	32	409	√	(√)	√	√
Gulumpe	59	4922	√	(√)	√	√
Asantekwa	45	1374	√	(√)	√	√
Sabule	26	926	√	(√)	√	√
Mansie	28	1243	÷	√	√	√
Miawani	29	963	√	√	√	√
Bonte	40	2719	√	√	√	√
Bomini	41	2189	√	√	?	√
Dromankese	61	6742	√	√	√	√

a: data from 2016 provided by Ghana Statistical Service in Kumasi.

Basic socio-economic characteristics of the households by income quartile are presented in Table 2. Average household size measured in aeu varies between 4 for income quartile 4 and 5 for income quartile 1. Apart from being significantly larger in size, the poorest households have significantly older household heads compared to the richest households in income quartile 4. Furthermore, there are slightly more widows and female headed households in the poorest households compared to the richest. However, the households in income quartile 3 and 4 include more divorced people than the poorer households. The differences regarding marital status and female headed households are though not found to be statistically significant.

The share of household heads belonging to the dominant tribe in the village is smallest for the poorest group of households in income quartile 1 (47%). Furthermore, there is a trend that richer households have a higher share of household heads belonging to the dominant tribe in the village. This pattern is though not found to be statistically signifi-

cant, and looking at the richest income quartile, this group of households have fewer household heads belonging to the dominant tribe in village than both income quartile 2 and 3.

Table 2: *Socio-economic characteristics of households by income quartile*

	Poorest (*n* = 100)	**2 (*n* = 100)**	**3 (*n* = 100)**	**Richest (*n* = 100)**	**Statistical significance[A]**
Household size (aeu)	5.0[b]	4.8[b]	4.7[ab]	4.0[a]	***
Age of household head	53.3[b]	51.4[b]	49.2[ab]	46.5[a]	***
Education level of household head:					**
- Illiterate	63%	55%	66%	50%	
- Informal	2%	0%	0%	0%	
- Basic	30%	34%	22%	34%	
- Secondary	5%	11%	11%	13%	
- Tertiary	0%	0%	1%	3%	
Female headed households	18%	12%	15%	9%	NS
Marital status of household head:					NS
- Married	81%	87%	83%	86%	
- Divorced	7%	2%	8%	8%	
- Widower	11%	10%	9%	5%	
- Unmarried	1%	1%	0%	1%	
Household head belonging to the dominant tribe in village	47%	60%	62%	54%	NS

[A] ANOVA F-test is used for finding statistical significance for the two first variables. The following variables are based on Chi-square tests. NS = Not Significant (level of significance >10%), *** = significant at 0.01 level & ** = significant at 0.05 level.
Note: When different superscripted letters appear within a row it implies that the difference between the numbers is significant at a 5% level according to Bonferroni's test.

Looking at human capital in the form of education levels, more than half of the sampled household heads are illiterate (on average ~59%). The majority of those with an education have a basic education (~30%), while a smaller group of people has been to secondary school (~10%). When comparing education levels of the poorest households

(income quartile 1) and the richest households (income quartile 4), the richest households are better educated. Nevertheless, households in income quartile 3 have the highest rate of illiteracy.

5 Results

The first part of this chapter presents an overview of households' income sources and their economic importance. In order to investigate whether some income sources, including charcoal income, are particularly important for households with a certain income level, income shares are categorized in income quartiles. Additionally, a distinction between subsistence income and cash income is made to enable an estimation of charcoal cash income. The second part of the chapter investigates what factors determine engagement in charcoal income generating activities. This includes socio-economic characteristics, aspects of social capital, and assets owned by households. This section also investigates the variation in charcoal income amongst households engaged in charcoal income generating activities and how these differences affect dependence on other income sources. The third part of the chapter explores the variation in charcoal income dependence between villages and examines what factors might cause such variation.

5.1 Sources of income

The households have a wide variety of income sources with crop production (47.5%) as the most important livelihood activity (Figure 5). The other half of households' income is dominated by three sources of income: charcoal production (12.5%), unprocessed environmental products (10.9%) and own business (9.4%).

From poorest to richest, the households are found to have an average total net income of 210.6 USD per aeu, 445.1 USD per aeu, 846.8 USD per aeu, and 2609.5 USD per aeu, and the differences between the quartiles are found to be statistically significant except between quartile 1 and 2 (Table 3). Differentiating between subsistence income and cash income (Table 4), half of income quartile 1's income is recorded as subsistence income and there is a tendency that the higher total income, the larger income share from cash income.

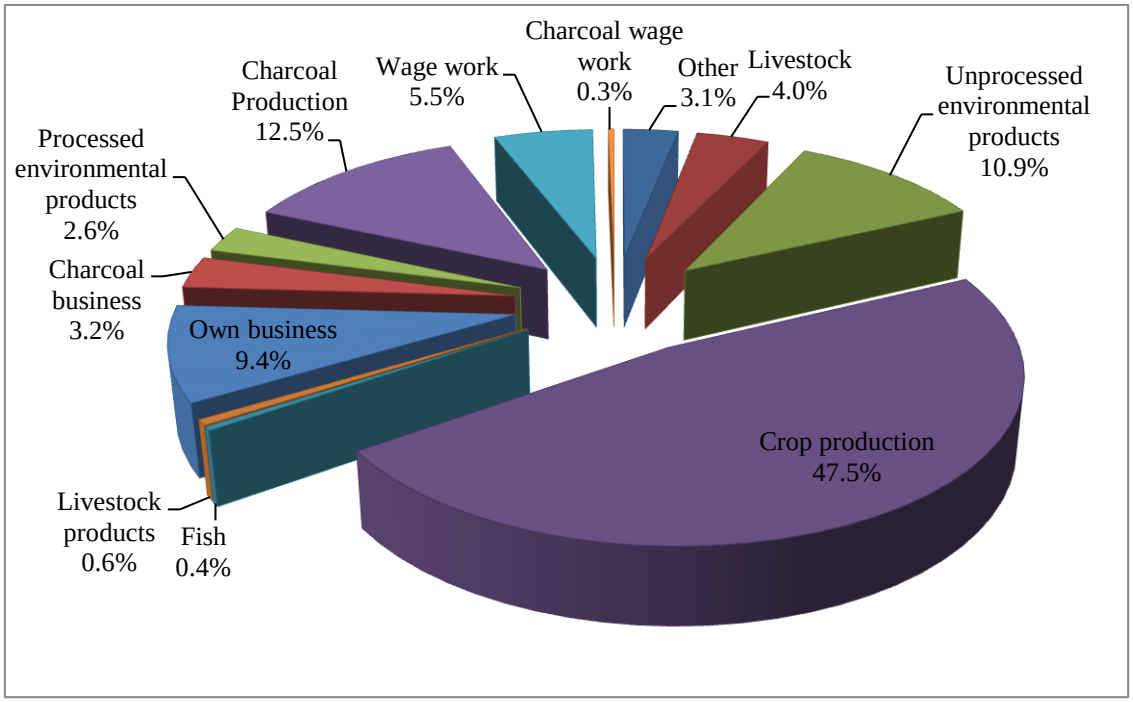

Figure 5: *The relative economic importance of income sources*

Note: Values are based on averages of individual households' income shares adjusted per aeu.

Table 3: *Relative and absolute income by income quartile*

	Poorest (*n* = 100)	**2 (*n* = 100)**	**3 (*n* = 100)**	**Richest (*n* = 100)**	**ANOVA F-test[A]**
Total net income (US$ per aeu)	210.6[a]	445.1[a]	846.8[b]	2609.5[c]	***
Charcoal business	0.6%[a] (1.2)	0.1%[a] (0.6)	2.8%[a] (23.9)	9.1%[b] (236.9)	***
Charcoal production	11.5% (24.3)	11.3% (50.4)	11.5% (97.6)	15.6% (406.8)	NS
Charcoal wage work	0.2% (0.4)	0.1% (0.5)	0.7% (5.8)	0.3% (7.5)	NS
Livestock	4.8% (10.1)	3.9% (17.4)	4.3% (36.4)	3.2% (82.9)	NS
Unprocessed environmental products	18.9%[c] (39.9)	11.9%[b] (53.1)	7.5%[a] (63.3)	5.4%[a] (141.2)	***
Fish	0.3% (0.6)	0.1% (0.5)	1.0% (8.3)	0.1% (2.6)	*
Crop production	47.6%[ab] (100.1)	55.3%[b] (246.0)	49.5%[b] (419.4)	37.5%[a] (978.1)	***
Livestock products	0.8% (1.7)	0.6% (2.7)	0.6% (4.9)	0.3% (6.6)	*
Own business	3.8%[a] (8.1)	4.3%[a] (19.2)	12.7%[b] (107.6)	16.9%[b] (441.9)	***
Processed environmental products	2.2% (4.6)	2.2% (9.6)	2.7% (23.2)	3.4% (89.6)	NS
Wage work	4.8% (10.1)	7.4% (33.0)	4.4% (36.9)	5.4% (141.9)	NS
Other incomes	4.4% (9.4)	2.7% (12.1)	2.3% (19.4)	2.8% (73.5)	NS

[A] NS = Not Significant (level of significance >10%), *** = significant at 0.01 level & * = significant at 0.1 level.

Note: 1.When different superscripted letters appear within a row it implies that the difference between the numbers is significant at a 5% level according to Bonferroni's test. 2. All income values are found in US$ and adjusted to aeu. The relative income for each income source is based on the mean of individual households' income share. The absolute value presented in bracket is based on the average of shares stated and the average total income by income group. The absolute value is hence not the average absolute income for each source.

Table 4: *Cash and subsistence income shares by income quartile*

	Poorest (*n* =100)		**2 (*n* = 100)**		**3 (*n* = 100)**		**Richest (*n* = 100)**	
	Cash	Subsistence	Cash	Subsistence	Cash	Subsistence	Cash	Subsistence
Charcoal business	0.6%	0.0%	0.1%	0.0%	2.8%	0.0%	9.1%	0.0%
Charcoal Production	11.2%	0.4%	11.1%	0.3%	11.4%	0.2%	15.4%	0.2%
Charcoal wage work	0.2%	0.0%	0.1%	0.0%	0.7%	0.0%	0.3%	0.0%
Livestock	2.5%	2.3%	2.3%	1.6%	2.8%	1.5%	2.1%	1.0%
Unprocessed environmental products	0.8%	18.1%	1.6%	10.3%	0.8%	6.7%	1.4%	4.0%
Fish	0.1%	0.2%	0.0%	0.1%	0.6%	0.4%	0.0%	0.1%
Crop production	19.3%	28.2%	25.9%	29.4%	22.8%	26.8%	19.7%	17.8%
Livestock products	0.8%	0.0%	0.6%	0.0%	0.4%	0.2%	0.2%	0.0%
Own business	3.8%	0.0%	4.3%	0.0%	12.7%	0.0%	16.9%	0.0%
Processed environmental products	0.8%	1.4%	0.7%	1.4%	1.8%	0.9%	2.9%	0.5%
Wage work	4.8%	0.0%	7.4%	0.0%	4.4%	0.0%	5.4%	0.0%
Other	4.4%	0.0%	2.7%	0.0%	2.3%	0.0%	2.8%	0.0%
Total	49.4%	50.6%	56.9%	43.1%	63.4%	36.6%	76.4%	23.6%
Total charcoal	12.0%	0.4%	11.3%	0.3%	14.8%	0.2%	24.8%	0.2%

Note: The relative income for each income source is based on the mean of individual households' income share.

5.1.1 Crop production and animal husbandry

Farming activities are found to be the largest contributor to people's income for households in all income quartiles both in relative and absolute values (Table 3). In total, 94.8% of households are registered to have a positive income from farming activities, indicating that almost all households are farming. The most important crops are yam, cassava, groundnut and maize, but also cashew nuts are an important cash crop for

many farmers. Looking at the variations among income quartiles, the richest households (income quartile 4) have the lowest average relative income share from crop production, which is significantly different from households in income quartile 2 and 3 which have the highest income share from crop production (Table 3). Furthermore, crops contribute with both the largest subsistence income share and the largest cash income share for all income quartiles (Table 4).

With an average income share of 4% for livestock and an additional 0.6% share from livestock products (eggs from chicken and guinea fowl), animal husbandry is of minor economic importance for all households (Figure 5). Still the majority of households have livestock (~80%) of which chicken and goats are the most commonly observed. Animals such as sheep, pigs, cattle, and guinea fowls are also observed, though not as frequently as chicken and goats. Furthermore, there is a tendency that livestock and livestock products are slightly more important for the poorest households (Table 3).

5.1.2 Unprocessed and processed environmental products (charcoal excluded)

With a 10.9% average share of households' income, unprocessed environmental products make up a considerable contribution to the sampled households' livelihoods (Figure 5). Firewood and bush meat are the most frequently registered products in this category, but many households rely on a wide variety of different products that they collect in their surrounding areas. Some products such as spear grass, poles, lianas, and vines are used as building materials, while other products like wild leaves, nuts, fruits, and mushrooms are ingredients in people's meals or supplements to their diets. Furthermore, medicinal plants are also found to be used by many households. Looking at the average income shares of unprocessed environmental products (Table 3), this income source is significantly more important for the households in the two poorest income quartiles (18.9% and 11.9%) compared to the richer households (7.5% and 5.4%). Furthermore, this income source mainly contributes with subsistence income, especially for the poorest households for whom subsistence income from unprocessed environmental products makes up ~96% (18.1 out of 18.9, see Table 4).

With an average of 2.6%, processed environmental products such as cooking utensils, crafts, brooms, bricks, and sawn timber make up a smaller fraction of households' income, provided that charcoal production is excluded from this category (Figure 5). Pro-

cessed products seem to be slightly more important for richer households, but the difference between the average shares is however not statistically significant (Table 3).

Although presented as a separate category, *fish* (comprising fish and crabs) can also be considered an environmental product. Fish contribute with less than one percent of households' income, with income group 3 having the biggest income share (Table 3).

5.1.3 Wage work, business and other incomes (charcoal excluded)

Wage work contributes with an average of 5.5% of households' income (Figure 5). Income quartile 2 has the highest average share of income from wage work, though not being significantly different amongst income quartiles (Table 3). The most frequently registered type of wage work is agriculture/plantation work.

Income from own business ranks the fourth highest amongst the 12 listed income activities (Figure 5). On average, this income share is 9.4% of households' income, and this income source seems to be particularly important for the richest households (income quartile 3 and 4) for whom it makes up 12.7% and 16.9% respectively of total income compared to only 3.8% and 4.3% for the households in income quartile 1 and 2 (Table 3). The absolute values for own business also underlines that this income source is predominant amongst the richest households, since income from own business is more than 50 times as high for income quartile 4 compared to income quartile 1. Food selling and brewing are examples of specific businesses recorded.

The income category *other incomes* mostly makes up financial support from friends and relatives who contribute with gifts and remittances. The highest income share of this category is found for households in income quartile 1. The difference is however not found to be statistically significant amongst the income quartiles.

5.1.4 Charcoal income

Overall, there are three charcoal income categories: *charcoal production, charcoal business*, and *charcoal wage work* where charcoal business is defined as income from charcoal which is not charcoal production or charcoal wage work. The average of each income share is 12.5%, 3.2% and 0.3% respectively (Figure 5) which all together results in a total of 16%. Hence, income from charcoal production contributes significantly to households' income and is only surpassed by crop production. The largest income share

form charcoal production is found for the richest income quartile (15.6%), while income quartile 1, 2 and 3 has an income share of ~11.5%, but the difference between the groups is not found to be statistically significant (Table 3). Thus interestingly, all households, regardless of income quartile, have similar high income shares from charcoal production. Furthermore, a total of 250 households (62.5% of all interviewed households, see Table 6) are recorded with an income from charcoal production, indicating that charcoal production is an income generating activity commonly practised by households.

Charcoal production contributes with households' second largest cash income only surpassed by crop production (Table 4). Charcoal production can therefore be considered an important source of cash income. Other important cash income sources are own business, wage work and other incomes. Only 0.2-0.4% of households' income can be categorized subsistence charcoal production income, while 11.1 – 15.4% of households' income is cash income from charcoal production (Table 4). Thus ~ 98% of income from charcoal production is cash income, indicating that the charcoal producing households sell most of their charcoal and only use a small fraction themselves. Table 5 shows that the share of cash income from charcoal production ranges from 17.9% to 22.6% with an average of 20%. If charcoal business and charcoal wage work is included, the share of cash income ranges from 19.9% to 32.5% with an average of 25%.

Table 5: *Charcoal's contribution to households' total cash income by income quartile*

Share of cash income from:	**Poorest (*n* = 100)**	**2 (*n* = 100)**	**3 (*n* = 100)**	**Richest (*n* = 100)**	**Average**
Charcoal production	22.6%	19.4%	17.9%	20.2%	20.0%
All charcoal activities	24.2%	19.9%	23.4%	32.5%	25.0%

Note: shares are based on income values presented in Table 4.

Additional findings further suggest that charcoal production is a vital income source when households face a crisis. The two most common types of crisis amongst households are crop failure and serious illness in family which is stated by ~53% and ~36% of respondents respectively. Looking at the responses to crisis, ~33% of the households

with a crop failure are producing charcoal as one of the means to overcome the crisis. This suggests that charcoal production is an important element in households' livelihood strategies in times of crisis.

Table 6 shows how many households engage in different charcoal income generating activities distributed according to income quartile. Looking at the households engaging in charcoal production, there is close to an equal number of producers in each income quartile, however with slightly fewer in income quartile 1.

Table 6: *Number of households participating in charcoal activities by income quartile*

Households engaging in:	**Poorest (*n* = 100)**	**2 (*n* = 100)**	**3 (*n* = 100)**	**Richest (*n* = 100)**	**Total**
Charcoal business only	4	0	3	6	13 (3.3%)
Charcoal business & production	0	2	5	8	15 (3.8%)
Charcoal business & wage work	0	0	0	0	0%
Charcoal business, wage work & production	2	1	1	4	8 (2%)
Charcoal production only	52	59	50	48	209 (52.2%)
Charcoal wage work only	1	0	0	0	1 (0.25%)
Charcoal wage work & production	5	3	6	4	18 (4.5%)
Charcoal production (total)	59	65	62	64	250 (62.5%)
Charcoal business (total)	6	3	9	18	36 (9.0%)
Charcoal wage work (total)	8	4	7	8	27 (6.8%)
Charcoal activities (production, business & wage work)	64	65	65	70	264 (66.0%)
No charcoal activities	36	35	35	30	136 (34%)
Total	100	100	100	100	400 (100%)

Table 7 shows the types of charcoal wage work and charcoal businesses registered in the survey and how many observations these make up. In total 29 observations of charcoal wage work has been recorded with 27 households engaged (~7% of all households). The most common type of charcoal wage work is charcoal production, but some household members are also engaged in bagging of charcoal and loading the bags on trucks. Charcoal wage work is contributing with a rather small income share for all income quartiles (0.1 – 0.7%) and the difference between them is not statistically significant.

Looking at charcoal business, the situation is somewhat different. Even though the share of households engaging in charcoal business is small (9% of all sampled households, see Table 6), the richest households, particularly in income quartile 4, have a significantly higher income share from charcoal business compared to the other households (Table 3). With an absolute value from charcoal business of 236.9 US$ per aeu, income quartile 4 has higher earnings from charcoal business than the total average income of households in income quartile 1 that have 210.6 US$ per aeu. Looking at Table 7, the most commonly observed type of charcoal business is charcoal trade which makes up 83% of all charcoal business. The remaining households constitute three chainsaw operators, one middleman, one transporter, and one selling trees to a producer. A trader is here defined as a person who buys charcoal and sells it again with a profit. He or she can either buy the charcoal directly from a producer or buy it from other traders. A trader can also hire a middleman to buy the charcoal for him/her after which the trader sells the charcoal. A middleman does therefore not sell charcoal; instead he/she gets a commission from the trader.

Table 7: *Prevalence of different types of charcoal wage work and charcoal business*

Charcoal wage work	***n* observations**	**Charcoal business**	***n* observations**
Production	15 (51.7%)	Traders	30 (83.3%)
Bagging	4 (13.8%)	Chainsaw operators	3 (8.3%)
Loading	10 (34.5%)	Others	3 (8.3%)
Total	29 (100%)	Total	36 (100%)

5.2 The determinants of charcoal income

The following sections focus on households with income from charcoal production and charcoal business. The purpose of this focus is to find out what characterizes these households by investigating and comparing their socio-economic characteristics, social capital, assets, and income with households having no charcoal production/business income. For this purpose four groups of households have been defined: 1) households with no income from charcoal production or charcoal business, 2) households with low charcoal production income, 3) households with high charcoal production income, and 4) households with charcoal business income.

As shown in Table 6, some households engage in several charcoal income generating activities. Some households with income from charcoal business therefore also have income from charcoal production. In order to be able to differentiate and statistically compare the groups, households in group 2 and 3 do therefore not engage in charcoal business. This means that the households who engage in both charcoal production and charcoal business are categorised in group 4. Due to the rather small contribution of charcoal wage work to the sampled households' income, engagement in charcoal wage work has not influenced the formation of the presented groups central to the further analysis. Moreover, as can be seen in Table 6, households with income from charcoal wage work all (except one) engage in charcoal production. When comparisons are made between households with no charcoal production/business income and households engaging in charcoal production or charcoal business, charcoal wage workers are thus included in the latter categories. Another argument not to focus on charcoal wage workers is that the number of households engaging in charcoal wage work is smaller than charcoal business. Furthermore, there is no income quartile with particularly many charcoal wage workers (see Table 6) suggesting that no specific type of households engage in charcoal wage work.

5.2.1 Socio-economic characteristics

Amongst socio-economic characteristics presented in Table 8 are measurements of human capital as well as the mediating factors: gender, age and ethnicity which are all likely to influence access to capitals.

The difference between the average ages of household heads is statistically significant if comparing households with no charcoal production/business income with the remaining households (Table 8). Well aware that household heads from households with charcoal production income may not necessarily do the charcoal production themselves and might even hire people to work for them, this result correlates well with the fact that charcoal production normally is seen as physically hard work. The lower average age of household heads in group 4 indicates that not only the production of charcoal, but also charcoal business is attracting younger people.

When looking at the marital status, household heads in households with no charcoal income have the highest share of divorced and widows (Table 8). With 24.1% of household heads being female for non-charcoal producers/business households compared to 7% and 5.3% for low and high charcoal producing households, households headed by women are less likely to engage in charcoal production (Table 8). Interesting is though that a good share of households headed by women engage in charcoal business (19.4%). When asking respondents who in the household did the work, most answer that it is both adult males and females (42%) or only/mainly the husband and adult male household members (~40%), while only a smaller share of respondents state that it is only/mainly the wife and adult female household members (~9%). Apart from the fact that there is an overweight of males in the production, these additional findings also show that amongst households with low charcoal production income it is more frequently primarily women (~14%) doing the work compared to ~5% amongst households with high charcoal production income. Even though household members do most of the work themselves, statements from enumerators along with the production costs recorded in the survey indicate that many households hire people for the production as well.

Table 8: *Socio-economic characteristics of households according to engagement in charcoal production and charcoal business*

	1. No charcoal business/ prod. income (*n* = 137)	**2. Low charcoal prod. Income (*n* = 114)**	**3. High charcoal prod. Income (*n* = 113)**	**4. Charcoal business income (*n* =36)**	**Statistical significance[A]**
Total net income (US$ per aeu)	874.3[a]	629.3[a]	1323.6[b]	1947.2[c]	***
Household size (aeu)	4.5	4.7	4.6	5.0	NS
Age of household head	54.1[b]	49.1[a]	47.7[a]	45.7[a]	***
Education level of household head:					NS
- Illiterate	58.3%	55.3%	65.5%	47.2%	
- Informal	0.7%	0.0%	0.9%	0.0%	
- Basic	29.2%	31.6%	27.4%	36.1%	
- Secondary	10.2%	11.4%	6.2%	16.7%	
- Tertiary	1.5%	1.8%	0.0%	0.0%	
Female headed households	24.1%	7.0%	5.3%	19.4%	***
Marital status of household head :					**
- Married	73.7%	89.5%	91.2%	86.1%	
- Divorced	11.7%	2.6%	2.7%	8.3%	
- Widower	13.1%	7.9%	5.3%	5.6%	
- Unmarried	1.5%	0.0%	0.9%	0.0%	
Household head belonging to the dominant tribe in village	66.4%	50.0%	50.4%	50.0%	**

[A] ANOVA F-test is used for finding statistical significance for the three first variables. The following variables are based on Chi-square tests. NS = Not Significant (level of significance >10%), *** = significant at 0.01 level & ** = significant at 0.05 level.

Note: When different superscripted letters appear within a row it implies that the difference between the numbers is significant at a 5% level according to Bonferroni's test.

Table 9: *Reliance on charcoal production income by ethnic group*

Tribe	Charcoal production income share	Average total income (US$ per aeu)	Number of interviews
Brong	4.8% (59.2)	1233.1	117
Mo	10.5% (78.8)	750.5	79
Dagarti	16.0% (116.9)	730.5	50
Kokomba	14.5% (160.6)	1107.3	46
Gonja	18.6% (299.7)	1611.1	25
Sissala	40.9% (541.1)	1323.1	23
Dagomba	6.1% (63.5)	1040.4	21
Tsokosti	14.0% (70.5)	503.3	13

Note: 1. Only tribes interviewed more than 10 times are included in the table. 2. The relative income is based on the mean of individual households' income share. The absolute value presented in bracket is based on the average of shares stated and the average total income by tribe. The absolute value is hence not the average absolute income.

Looking at the education level of household heads among the defined charcoal groups (Table 8), charcoal business households are best educated, since they have the lowest rate of illiteracy and the highest rate of household heads who has attended basic- and secondary school. The education level amongst charcoal producers is found to be highest for households with a low charcoal production income. Comparing households with no charcoal production/business income with charcoal producing households the former are better educated than the households with high charcoal production income but slightly less educated than the households with low charcoal production income. The observed trends regarding education are though not found to be statistically significant.

The share of household heads belonging to the dominant tribe in village is significantly larger for the households who do not engage in charcoal production or charcoal business (66.4%) compared to those households with charcoal income (~50%) (Table 8). The importance of charcoal production income also varies between tribes, where the Sissala people with 40.9% of their income from charcoal production are found to be most reliant on the production (Table 9). This might indicate that households with a certain ethnic background are more likely to be engaged in charcoal activities.

5.2.2 Social capital

Nurturing your network or being a member of a social group/association can be seen as an investment in the future, since good relations are likely to open up for new (or strengthen already existing) income generating activities. In the case of a crisis these relations can also give a helping hand and thus increase a households' livelihood security (Ellis, 2000). Indicators used for measuring social capital are here households' statements regarding trust to - and possibilities to get help from other people in the community as well as membership in user groups.

Table 10: *Households' trust in and ability to get help from other villagers*

	No charcoal business/ prod. income (*n* = 137)	**Low charcoal prod. income (*n* = 114)**	**High charcoal prod. income (*n* = 113)**	**Charcoal business income (*n* =36)**	**Chi-square test[A]**
Trust people in community:					NS
- No	6.6%	9.7%	3.5%	2.8%	
- Yes	56.2%	50.9%	60.2%	66.7%	
- Some	37.2%	39.5%	36.3%	30.6%	
Can get help from people in community:					NS
- No	16.8%	19.3%	11.5%	13.9%	
- Yes	50.4%	61.4%	56.6%	61.1%	
- Partly	32.9%	19.3%	31.9%	25.0%	

[A] NS = Not Significant (level of statistical significance >10%)

Based on the results in Table 10, households with high charcoal production income or charcoal business income have more trust in other people in their village than households with no charcoal production/business income and those with only little charcoal production income. Furthermore, group 3 and 4 also express higher abilities to rely on people in their village when they are in need of help for instance if they need money because a family member is sick. These findings thus suggest that households with highest charcoal income have a higher social capital which improves their livelihood

security. This conclusion should though be made with caution, since the results are not found to be statistically significant.

Table 11: *Households' engagement and membership in charcoal user groups*

	1. No charcoal business/ prod. income (*n* = 137)	**2. Low charcoal prod. income (*n* = 114)**	**3. High charcoal prod. income (*n* = 113)**	**4. Char-coal business income (*n* =36)**	**Chi-square test[A]**
Membership of CUG	3 (2.2%)	-	14 (12.4%)	9 (25.0%)	***
Attends CUG meetings/activities	2 (1.5%)	-	9 (8.0%)	7 (19.4%)	***
Pay amount to CUG	1 (0.7%)	-	7 (6.2%)	3 (8.3%)	***
Receive amount from CUG	1 (0.7%)	-	1 (0.9%)	-	NS

[A] NS = Not Significant (level of significance >10%) & *** = significant at 0.01 level.

Another aspect worth investigating when looking at social capital is the extent of user groups in the studied communities. The questionnaire therefore includes questions regarding participation in Forest User Groups (FUGs) and Charcoal User Groups (CUGs). Generally, households were not found to be members of a FUG. Some did though state to be "fire volunteers" which is villagers organising themselves in order to prevent damages of fire outbreaks. Other findings do however show that the fire volunteer-groups are inactive these days. Based on this information, FUGs are not considered to play a significant role in the formation of social groups/network and inclusion in the studied communities. Two of the 10 villages were found to have active CUGs (in Bonte and Dromankese). However, a few recordings were also made about such memberships in two other villages, but the presence of CUGs in these villages has not yet been confirmed elsewhere. Like in the case with the FUGs, some contradictory statements were thus found regarding the presence of CUGs in the villages.

Looking at how many households stated a CUG membership (Table 11), the highest membership rate is found amongst households engaging in charcoal business, and the

second highest rate is found amongst households with a high charcoal production income. Some households also state a membership even though they are not categorised as having any income from charcoal business or production. The reason for this can be that the households in question have been engaged in charcoal business/production before 2016. The persons who take part in the CUG meetings/activities are almost all male members of the households with the majority being the husband. Two households state that it is the wife who attends, and two state that it is both the husband and the wife where two of these households have income from charcoal business. The reasons stated for joining a CUG vary from being forced to join the group to believing that the CUG can reduce conflicts over resources. However, most people state the social aspect (meeting people, working together, fear of exclusion, etc.) as a reason. Even though some state that the CUG has had no effect, most statements suggest a positive effect.

The findings thus suggest that cooperative activities could have a positive influence on charcoal production and charcoal business income.

5.2.3 Assets

As a part of investigating which factors influence households' dependence on charcoal income and their engagement in charcoal activities, households have been asked whether they own certain assets or not. Having information about households' ownership of assets can help describe whether groups of households are more well of or less well of than other groups. The annual income of households, presented in the next sections of this chapter, is also an indicator of wealth, but annual incomes are likely to vary from year to year. Measuring asset holdings is thus a way to describe households' wealth status that is less prone to be influenced by annual fluctuations (Angelsen & Lund, 2011). Apart from having a certain economic value and defining material standards of living, some assets are potential *producer goods* where the use of an asset supplies a household with income (Ellis, 2000). The portfolio of assets can thus influence the income generating opportunities of a household.

Overall a larger share of households engaged in charcoal business own one or more of the listed items compared to the three other groups of households (Table 12). Looking at the 20 first listed items, this group gets the highest score 16 times. These items include car, motorbike, tractor, plough, wheelbarrow, mobile phone, TV, cas-

sette/CD/VHS/VSD/DVD player, radio, stove, refrigerator/freezer, furniture, chainsaw, water pump, solar light, and solar panel. Worth noticing is though, that the difference between shares 8 out of the 16 times are not statistically significant. For four types of assets (bicycle, camera, computer and gun), households with high charcoal production income have the highest scores. Furthermore, households with high charcoal income are generally more likely to own assets than households with low charcoal income. For some producer goods like for instance a chainsaw the high charcoal income group and charcoal business group have considerably higher scores than other households (23% and 41.7% respectively compared to 4.4% and 5.3%). Owning a chainsaw can increase households' charcoal income generating opportunities which can explain their higher charcoal income. Households' ownership of items facilitating transport of goods is also relevant to have a closer look at. Additional findings from the household survey show that ~ 22% of charcoal producing households sell some of their charcoal outside the village. Moreover, the results show that only ~7% of households with low charcoal production income sell charcoal outside the village. This figure is significantly higher for households with high charcoal income (32%) and households with charcoal business income that produce charcoal (~43%). Having this in mind, the distribution of items related to transport amongst households (car, motorbike, bicycle, tractor, and wheelbarrow/ wooden chart) fits fairly. There is generally a slightly higher frequency of transport items amongst households with high charcoal production income, and households with charcoal business income especially get high scores when it comes to wheelbarrow/ wooden chart (25%).

Looking at house ownership and the materials houses are made of (the remaining three asset categories in Table 12), the picture is somewhat different. Households with charcoal income (especially those not engaging in charcoal business) are more likely to live in a house with mud/soil walls and thatch than households with no charcoal income that have high scores on brick/concrete walls and iron roof. Apart from living in better houses, households with no charcoal income also more often own their own house, thus fewer households are renting a house in this group. Even though the results for both ownership of house and roof material are found not to be statistically significant, there is here a trend that households with no charcoal income are better off when it comes to condition and ownership of houses. The lower frequency of households with brick/concrete

walls amongst charcoal producers might be explained by the fact that some villages are shifting away from using mud/soil as building material. This is for instance the case in Bonte and Bomini, which also have the lowest share of charcoal producers amongst villages.

In addition to the above presented recordings of assets, households were also asked how well-off they believe their household is compared to other households in the community. Here the results show that households engaged in charcoal business to a much higher extend find themselves better-off than the other groups of households. The distribution amongst the other groups is less pronounced, but the general pattern is that households with high charcoal production income appear to be better-off than the two remaining groups, where households with low charcoal production are least well-off. This pattern is further supported by enumerators' assessment of households' wealth. These additional findings thus correlate well with the general pattern of asset holding, if we ignore the mismatching results of house-standard and ownership.

There is thus no clear indication that households engaged in charcoal production or charcoal businesses have more assets or are more or less well-off than other households, but there is a tendency that scores on assets and wealth are highest for group 3 and 4 and lowest for group 1 and 2.

Table 12: *Selected assets owned by households*

	1. No charcoal business/ prod. income (*n* = 137)	**2. Low charcoal prod. income (*n* = 114)**	**3. High charcoal prod. income (*n* = 113)**	**4. Charcoal business income (*n* =36)**	**Chi-square test[A]**
Car	2.9%	3.5%	6.2%	11.1%	NS
Motorbike	25.6%	26.3%	35.4%	41.7%	NS
Bicycle	65.0%	81.6%	90.3%	75.0%	***
Tractor	1.5%	3.5%	2.7%	8.3%	NS
Plough	0.7%	0.9%	0%	5.6%	**
Wooden cart/ wheelbarrow	2.9%	1.8%	2.7%	25.0%	***
Mobile phone	81.0%	79.8%	76.1%	94.4%	NS
TV	31.4%	29.0%	24.8%	50.0%	**
Cassette/CD/ VHS/VSD/ DVD player	16.8%	15.8%	14.2%	36.1%	**
Radio	65.7%	67.5%	76.1%	83.3%	*
Camera	1.5%	1.8%	2.7%	0%	NS
Computer/ laptop	2.2%	2.6%	2.7%	0%	NS
Stove (charcoal/gas)	52.6%	63.2%	63.7%	72.2%	*
Refrigerator/ freezer	9.5%	4.4%	7.1%	16.7%	NS
Furniture	86.9%	84.2%	88.5%	88.9%	NS
Gun	16.8%	21.1%	35.4%	30.6%	***
Chainsaw	4.4%	5.3%	23.0%	41.7%	***
Water pump	2.2%	3.5%	8.9%	11.1%	**
Solar light	2.2%	1.8%	2.7%	5.6%	NS
Solar panel	0.7%	0%	2.7%	2.8%	NS
Own house	90.5%	88.6%	87.6%	86.1%	NS
Bricks/concrete walls	75.9%	57.0%	53.1%	61.1%	***
Iron/other metal sheets	80.3%	67.5%	71.7%	72.2%	NS

[A] NS = Not Significant (level of significance >10%), *** = significant at 0.01 level, ** = significant at 0.05 level & * = significant at 0.1 level.

5.2.4 Income level and share of income sources

Table 13 displays the average income shares and corresponding absolute values for each defined charcoal group along with the average total net income. Households with low charcoal production income also have the lowest total income of the four groups (629.3 US$ per aeu). Furthermore, the difference between this groups' total income and the total income of households in group 3 (1323.6 US$ per aeu) and group 4 (1947.2 US$ per aeu) is significant. Additionally, households with low charcoal production income are more dependent on unprocessed environmental products than the other groups, particularly group 3 and 4. Looking at the income share from wage work, households with low charcoal production income are also more dependent on this activity than group 3 and 4. Those households that are *not* engaged in charcoal production or charcoal business have some things in common with the group of households with low charcoal income such as a high dependency on unprocessed environmental products, wage work, and crop production. There are however also some differences between the two groups that should be mentioned. First, group 1 has the highest income share from own business (14.8%) and secondly, it also has the highest income share from *other income* (6%). For both of these categories group 2 has a significantly lower income share. Apart from having a high income, households with charcoal business income get 35.1% of their income from charcoal business and 11.1% from other own business. Furthermore, this group also has 8.9% income from charcoal production which makes this group the one with the highest income share from charcoal activities (44.4%).

What is important to add to the presented incomes is that there is a substantial variation in charcoal production income within the two charcoal production income groups as low charcoal production income ranges from 1.6 US$ per aeu to 56.7 US$ per aeu, whereas high charcoal production income ranges from 57.1 US$ per aeu to 6071.3 US$ per aeu.

Table 13: *Relative and absolute income by groups indicating households' engagement in charcoal production and charcoal business*

	1. No charcoal business/ prod. income (*n* = 137)	**2. Low charcoal prod. income (*n* = 114)**	**3. High charcoal prod. income (*n* = 113)**	**4. Charcoal business income (*n* =36)**	**ANOVA F-test[A]**
Total net income (US$ per aeu)	874.3[a]	629.3[a]	1323.6[b]	1947.2[c]	***
Charcoal business	-	-	-	35.1% (682.8)	-
Charcoal production	-	7.3%[a] (46.1)	34.0%[b] (449.9)	8.9%[a] (173.5)	***
Charcoal wage work	0.0% (0.1)	0.3% (1.6)	0.7% (9.7)	0.4% (7.7)	NS
Livestock	4.5% (39.3)	4.4% (27.5)	3.8% (49.6)	2.3% (44.1)	NS
Unprocessed environmental products	10.5%[ab] (92.2)	14.7%[b] (92.2)	9.0%[a] (119.7)	6.6%[a] (128.8)	***
Fish	0.4% (3.1)	0.6% (3.9)	0.2% (3.2)	0.1% (1.2)	NS
Crop production	54.7%[b] (478.0)	54.7%[b] (344.0)	37.0%[a] (489.5)	30.1%[a] (586.4)	***
Livestock products	0.6% (4.8)	0.7% (4.5)	0.4% (5.4)	0.6% (11.0)	NS
Own business	14.8%[b] (129.6)	4.4%[a] (28.0)	7.5%[a] (98.6)	11.1%[ab] (215.7)	***
Processed environmental products	3.0% (26.1)	1.8% (11.5)	2.8% (36.6)	3.4% (66.7)	NS
Wage work	5.6%[ab] (49.0)	9.4%[b] (59.2)	3.0%[a] (39.7)	0.6%[a] (12.6)	***
Other income	6.0%[b] (52.2)	1.7%[a] (10.8)	1.6%[a] (21.4)	0.9%[a] (16.7)	***

[A] NS = Not Significant (level of significance >10%) & *** = significant at 0.01 level.

Note: 1. When different superscripted letters appear within a row it implies that the difference between the numbers is significant at a 5% level according to Bonferroni's test. 2. All income values are found in US$ and adjusted to aeu. The relative income for each income source is based on the mean of individual households' income share. The absolute value presented in bracket is based on the average of shares stated and the average total income by group. The absolute value is hence not the average absolute income for each source.

Additionally, ~27% of households with a charcoal income state that income from charcoal is the major or only source of income in a period of the year. Here households with low charcoal production income more frequently state that the reason for this is that there is no other or not enough income from other activities compared to households with high charcoal production income or charcoal business income. The two latter groups of households to a higher degree answer that charcoal income generating activities are more profitable than other income sources. These additional findings thus suggest that even though households have a rather low charcoal income it does not mean that this income is not important, since it act as a gab filling income for many of these households.

In order to analyse variations within the group of households engaged in charcoal business, this group is divided into four quartiles according to their charcoal business income (Table 14). First of all, there is a certain variation in the total net income of these households and comparing these incomes to the total net income of income quartiles (Table 3) the group of households with the lowest charcoal business income has a total net income just above income quartile 2, and charcoal business income group 2 and 3 have a relatively high total income which can be placed between income quartile 3 and 4. Further interesting is that the group of households having the highest charcoal business income has a 3 times higher total net income than households in charcoal business income quartile 3. The reason why this group has such a high income is primarily because of the high income from charcoal business. With 71.7% of their income deriving from charcoal business, group 4 has a significantly higher income from this activity compared to the other charcoal business income quartiles. Especially group 1 and 2 have relatively low income shares from charcoal business while group 3 with 49.3% (like group 4) has a significantly higher income share from this activity. The other income sources thus become more important for the households with lower charcoal business income. Looking at income from unprocessed environmental products and crop production it is evident that these income sources become especially important for the households with lowest charcoal business income. Holding this information together, the findings show that households with a charcoal business income generally have high total net incomes and that a few have especially high charcoal business incomes.

The types of charcoal business that households are engaged in can help explain why there is such a variation in incomes amongst charcoal business income quartiles. Charcoal business income quartile 1 has the highest number of non-traders (4 out of 9) including a middleman, two chainsaw operators, and one selling trees to a producer. Charcoal income quartile 2 and 4 only have one household each that is not a charcoal trader; a chainsaw operator and a transporter respectively, while all households in charcoal business income quartile 3 are charcoal traders. Having so few observations of non-traders makes it difficult to generalize, but there is a tendency that households not characterized as charcoal traders are economically poorer households with corresponding smaller income from charcoal business. The registered charcoal transporter in charcoal business income quartile 4 is though found to have relatively high incomes (both total income and charcoal business income). Amongst the charcoal business households that are not charcoal traders there is thus found some variation. Furthermore, 5 out of 6 charcoal business households not being classified as charcoal traders do also produce charcoal. Though, still including a substantial number of charcoal producers, this number is lower for charcoal traders (18 out of 30, ~60%). Furthermore, 7 out of 8 households engaged in charcoal business are traders as well as wage workers, though with only one household in charcoal business income quartile 4 engaging in wage work. Producing charcoal and doing charcoal wage work is thus not only restricted to one type of charcoal business households.

Table 14: *Relative and absolute income by charcoal business income quartile*

	1. Low charcoal business income (*n* = 9)	**2. (*n* = 9)**	**3. (*n* = 9)**	**4. High charcoal business income (*n* =9)**	**ANOVA F-test[A]**
Total net income (US$ per aeu)	489.7[a]	1162.8[a]	1504.6[a]	4631.8[b]	***
Charcoal business	3.9%[a] (19.2)	15.3%[a] (178.2)	49.3%[b] (742.0)	71.7%[c] (3320.5)	***
Charcoal production	13.1% (64.2)	8.5% (98.8)	5.3% (80.3)	8.7% (402.6)	NS
Charcoal wage work	0.3% (1.6)	0.7% (7.8)	0.5% (7.0)	0.1% (5.4)	NS
Livestock	1.6% (7.6)	3.9% (45.1)	2.4% (36.7)	1.2% (55.2)	NS
Unprocessed environmental products	15.2%[b] (74.6)	5.8%[a] (68.0)	3.2%[a] (47.4)	2.2%[a] (102.9)	***
Fish	0.0% (0.0)	0.2% (2.6)	0.0% (0.2)	0.0% (0.3)	NS
Crop production	53.6%[c] (262.5)	38.4%[bc] (446.9)	21.0%[ab] (316.2)	7.4%[a] (343.4)	***
Livestock products	0.6% (3.0)	1.2% (13.6)	0.4% (6.2)	0.1% (3.1)	NS
Own business	7.1% (34.5)	12.5% (145.4)	16.5% (248.5)	8.3% (382.3)	NS
Processed environmental products	1.5% (7.2)	12.1% (140.1)	0.1% (1.3)	0.1% (4.2)	*
Wage work	1.0% (4.7)	0.6% (7.0)	0.9% (13.3)	0.1% (6.4)	NS
Other income	2.1% (10.5)	0.8% (9.2)	0.4% (5.6)	0.1% (5.5)	*

[A] NS = Not Significant (level of significance >10%) , *** = significant at 0.01 level & * = significant at 0.1 level. *Note*: 1. When different superscripted letters appear within a row it implies that the difference between the numbers is significant at a 5% level according to Bonferroni's test. 2. All income values are found in US$ and adjusted to aeu. The relative income for each income source is based on the mean of individual households' income share. The absolute value presented in bracket is based on the average of shares stated and the average total income by group. The absolute value is hence not the average absolute income for each source.

The categories in Table 15 are based on households' total charcoal income in absolute terms. It does not include households with no charcoal income and neither does it differentiate between households engaging in charcoal business or not. Thus both charcoal production, business and wage work is included. In this way the grouping takes into consideration the earlier mentioned variation in charcoal production income and charcoal business income.

The results show that those with the lowest charcoal income have a total average net income of 479.4 US$ per aeu (Table 15) which is considerably higher than the total average net income of the poorest income quartile in Table 3 (which is 210.6 US$ per aeu). Charcoal income quartile 2 and 3 have similar total net incomes (807.5 and 775.1 US$ per aeu respectively), while households in charcoal income quartile 4 have a total net income of 2356.1 US$ per aeu (Table 15). Households with the highest charcoal income thereby have an average income corresponding to households in the richest income quartile (Table 3).

Looking at the variation in charcoal income, there is an overall pattern of specialization. Charcoal income group 4's high charcoal business income is influenced by the households that have specialized in charcoal trade. The high dependence on charcoal production income for group 3 and 4 also implies that specialization takes place amongst charcoal producers. Crop production remains the most important income source for most people with a charcoal income. However, with only 22.2% of their income from crop production, the households with the highest income from charcoal (total charcoal income ~57%) are more economically reliant on charcoal production (38.4%) than on farming (Table 15). This group has thus specialized in charcoal income generating activities and gained on it. Charcoal wage work ranges from 0.1 – 1.2% of households' income with a trend (though not statistically significant) that households with higher charcoal income have the biggest shares. Charcoal wage work is thus of minor economic importance for all charcoal income quartiles.

With 16.6% of households' total income, unprocessed environmental products contribute with a considerable income share for the households with lowest income from charcoal activities. The remaining charcoal income quartiles rely less on unprocessed environmental products (6.1 – 11.7%) with a trend that those with higher charcoal income

are least dependent. The differences in average total net income taken into consideration, these findings correlates with the earlier findings (Table 3) that poorer households rely more on unprocessed environmental products.

The reliance on *other income* is lowest for households in charcoal income quartile 4, and looking at the correlating absolute values, charcoal income quartile 2 and 3 have the highest values. A similar pattern goes for wage work where households with lower charcoal income are more reliant on wage work. With 11% of their total income, households in charcoal income quartile 1 are significantly more dependent on wage work than households in charcoal income quartile 4 that have 1.9% of their income from wage work.

Apart from the fact that charcoal income group 3 has a slightly lower total income than charcoal income group 2, there is a relation between higher total income and higher charcoal income. Especially with a specialization in charcoal business the total income rises considerably.

Table 15: *Relative and absolute income by charcoal income quartile*

	1. Lowest charcoal income (*n* = 66)	**2. (*n* = 66)**	**3. (*n* = 66)**	**4. Highest charcoal income (*n* =66)**	**ANOVA F-test[A]**
Total net income (US$ per aeu)	479.4[a]	807.5[a]	775.1[a]	2356.1[b]	***
Charcoal business	0.1%[a] (0.6)	0.4%[a] (3.6)	1.3%[a] (10.1)	17.2%[b] (406.3)	***
Charcoal production	4.5%[a] (21.7)	11.4%[a] (91.8)	21.4%[b] (165.9)	38.4%[c] (905.0)	***
Charcoal wage work	0.2% (0.9)	0.1% (0.8)	0.4% (3.1)	1.2% (29.4)	NS
Livestock	4.4% (21.0)	3.7% (30.1)	4.2% (32.4)	2.9% (68.8)	NS
Unprocessed environmental products	16.6%[b] (79.7)	11.7%[ab] (94.4)	10.2%[a] (78.8)	6.1%[a] (143.2)	***
Fish	0.1% (0.4)	1.0% (8.1)	0.3% (1.9)	0.2% (4.4)	*
Crop production	55.1%[b] (264.2)	52.3%[b] (422.4)	45.9%[b] (355.7)	22.2%[a] (523.0)	***
Livestock products	0.7% (3.4)	0.8% (6.3)	0.6% (4.4)	0.2% (4.9)	NS
Own business	4.2% (20.1)	7.8% (62.7)	7.4% (57.3)	7.1% (168.2)	NS
Processed environmental products	1.6% (7.6)	3.2% (25.8)	3.0% (23.5)	1.9% (45.6)	NS
Wage work	11.0%[b] (52.7)	5.4%[ab] (43.2)	3.5%[a] (27.2)	1.9%[a] (44.3)	***
Other income	1.5%[ab] (7.0)	2.3%[b] (18.4)	1.9%[ab] (14.7)	0.6%[a] (13.1)	**

[A] NS = Not Significant (level of significance >10%), *** = significant at 0.01 level, ** = significant at 0.05 level & * = significant at 0.1 level.

Note: 1. When different superscripted letters appear within a row it implies that the difference between the numbers is significant at a 5% level according to Bonferroni's test. 2. All income values are found in US$ and adjusted to aeu. The relative income for each income source is based on the mean of individual households' income share. The absolute value presented in bracket is based on the average of shares stated and the average total income by income group. The absolute value is hence not the average absolute income for each source.

5.3 Geographic variations

This section presents the variation in charcoal income (charcoal wage work, production and business) within the 10 study sites. Subsequently, remoteness of the study sites will be examined as a mean to explain the variation observed. Since most charcoal produced in villages is transported to urban areas, physical capital in the form of access to roads is a relevant aspect to investigate. Furthermore, as indicated in the literature review Khundi et al. (2011) find a relation between households' participation in charcoal production and distance to roads as well as distance to forests, where a shorter distance increase the production. The importance of forests/ availability of trees in and around study sites are thus also discussed, but due to limited information about this potential factor, this aspect cannot be fully examined. Finally, mediating factors with focus on ethnicity will be included in the analysis.

Table 16: *Charcoal income and total income by village*

Village	Charcoal income	Average total net income
Kunsu	22.7% (201.0)	886.6
Chiranda	30.2% (259.9)	859.4
Gulumpe	21.3% (284.2)	1331.8
Asantekwa	7.2% (49.0)	681.5
Sabule	8.0% (84.8)	1058.3
Mansie	14.8% (97.8)	661.7
Miawani	23.1% (230.6)	999.4
Bonte	12.6% (162.8)	1293.0
Bomini	6.2% (68.5)	1105.4
Dromankese	15.6% (170.5)	1089.9

Note: 1. Total net income values are found in US$ and adjusted to aeu 2. The relative income for each income source is based on the mean of individual households' income share. The absolute value presented in bracket is based on the average of shares stated and the average total income by income group. The absolute value is hence not the average absolute income for each source

The average importance of charcoal income for households varies considerably across villages and ranges from 6.2% in Bomini to 30.2% in Chiranda (Table 16). With ~37

km to a major road, Dromankese and Miawani can be considered the most remote villages (Table 17). Furthermore, Miawani is the only village that does not have a usable road all seasons. This place can thus be considered more isolated than the remaining villages. Looking at the dependence on charcoal income in Dromankese (15.6%) it can be considered medium, but Miawani and Kunsu, which are amongst the most remote villages, both get high scores when it comes to dependence on charcoal income. However, Chiranda, the village most dependent on charcoal income, is located at the roadside to a major road, and is therefore amongst the least remote villages. Gulumpe is also placed next to a major road and have the fourth highest dependence on charcoal income.

Table 17: *Remoteness of villages*

Village	Distance to major road (km)	Road all seasons
Kunsu	29	√
Chiranda	0	√
Gulumpe	0	√
Asantekwa	11.5	√
Sabule	23.5	√
Mansie	15	√
Miawani	37.1	÷
Bonte	26.3	√
Bomini	27.7	√
Dromankese	37.7	√

Note: A major road is here defined as being the tarmacked national routes N10 and N12. The distances to roads are found in Google Earth based on GPS coordinates from study sites.

The results do therefore not show any clear connection between charcoal income dependence and remoteness of villages, meaning that this study cannot confirm earlier findings.

Based on information from focus group meetings and semi-structured interviews, Kunsu and Cheranda, which get high scores on dependency on charcoal income, both have a forest reserve nearby. However, the villagers stated that they are not allowed to fell

trees in the reserves, and without information about the actual density of trees in these forest reserves compared to the surrounding areas it also remains rather unclear whether these study sites have higher tree densities. Even though local variations are likely to appear, the general regional pattern of more forest in the south along with the fact that Boabeng Fiema Monkey Sanctuary is in the vicinity of Bonte and Bomini indicates that these sites are likely to have higher densities of trees than the other study sites. However, since villagers state that they do not fell trees for charcoal in the sanctuary, and since trees for charcoal production to a large extend is found on farm and fallow land, the density of trees might not have a big influence on charcoal production. Moreover, dependency on charcoal income (Table 16) is not high – in fact Bomini has the lowest charcoal income share amongst villages. Instead both villages get relatively higher incomes from own business (not related to charcoal). Results also show that there is some correlation between higher population in villages and higher share of income from the category own business, since Drumankese, Gulumpe, Bonte, and Bomini have the highest population rates (Table 1) along with the highest income share from own business. Furthermore, these villages have higher average total net incomes (Table 16). A high population number along with higher total income does though not indicate lower charcoal dependency, since villagers in Gulumpe are found to have a relatively high charcoal dependence.

Institutions like rules, customs, and land/tree tenure (presented in section 4.2) are all mediating factors that can influence the access to natural capital including wood resources for charcoal production. Individual migrants' relatively high payments for trees for charcoal production in Bomini could for instance be part of the explanation for the lower importance of charcoal income for inhabitants in this village. But the result is also likely to be influenced by the ethnicity of respondents. As earlier findings suggest, ethnicity might have an impact on households' income from charcoal production (Table 9). The number of migrants and certain tribes in villages might therefore also influence the average income share from charcoal activities. Looking at the possible connection between charcoal income and ethnicity of respondents, Bomini has a relatively low income share from charcoal (Table 16) as well as a high share of respondents belonging to the dominant tribe in village (Table 18) suggesting the presence of fewer migrants. Likewise Bonte, Sabule, and Mansie all have a relatively low charcoal dependence

compared to other villages, and in these villages a high share of respondents belong to the dominant tribe. Contrary Chiranda, Kunsu, Miawani, and Gulumpe have high dependencies on charcoal income along with a lower rate of respondents belonging to the dominant tribe in village. The general pattern thus shows a tendency that villages with fewer respondents belonging to the dominant tribe are more dependent on charcoal income. However, this does not necessarily mean that the dominant tribe in a village has a low dependency on charcoal, since Gonja and Dagarti people generally have high charcoal production incomes (Table 9). Neither does it mean that households not belonging to the dominant tribe in village necessarily have a higher dependence on charcoal income. Also, Asantekwa does not have a particularly high share of respondents belonging to the dominant tribe. The explanation for the observed low charcoal income share for this village might be because tree resources have declined much in this village due to a high charcoal production in the past.

Table 18: *Distribution of respondents belonging to the dominant tribe in village*

Village	Dominant tribe in village[a]	Share of respondents[b] belonging to the dominant tribe
Kunsu	Dagarti	29.0%
Chiranda	Mo	21.2%
Gulumpe	Gonja	35.0%
Asantekwa	Mo	60.0%
Sabule	Mo	74.1%
Mansie	Mo	79.3%
Miawani	Dagarti	53.3%
Bonte	Brong	73.2%
Bomini	Brong	78.6%
Dromankese	Brong	61.3%

a: Unfortunately there is no information available about the actual size of ethnic groups in villages, so this is based on villagers statements and discussions during focus group meetings. b: this is based on information on ethnicity of the household head.

Another factor likely to influence dependence on charcoal income is the presence of, or lack of, credit facilities. During an interview in Miawani it was explained that charcoal

production has increased in the area because it is more lucrative than farming, since charcoal buyers/traders can give producers money in advance if they promise to produce for them. If a person wants to lend money for crop production and has to go to a bank it is much harder to get the money he/she needs. This can thus be part of the explanation for the high charcoal income dependence in Miawani. The pre-financing of producers was however also reported in Mansie, where charcoal's economic importance is not particularly high. Due to little information about the presence and supply of financial arrangements such as pre-finance of charcoal production this aspect it thus something that needs further investigation.

Summing up, there is found no clear relation between the investigated factors and charcoal income in villages. The conclusions about the relation between availability of trees or financing of charcoal and charcoal dependence is though rather fragile due to limited information on these subjects. The difficulties in finding an explanation for the varying charcoal dependence could be because several factors are influencing charcoal income. Furthermore, there might be other factors not investigated here that are likely to have an effect on the economic importance of charcoal production in villages. This could for instance be the number of years charcoal production has been practiced in villages.

6 Discussion

This chapter falls into three parts. First, the results of the study will be compared with existing literature on charcoal's economic contribution to households' income and the determinants of charcoal income. The second part discusses limitations and weaknesses in the study. Finally, the last part of the chapter presents recommendations and suggestions for further research.

6.1 Comparing results with existing knowledge

Even though the scale of this study as well as the income categories differ from the PEN study by Angelsen et al. (2014), a comparison can still be made between the two studies because of the similar methodology used. Angelsen et al. (2014) finds that charcoal on a global level only contributes with a small share of income from wood fuels derived from forests (11%). Wood fuels here accounts for 7.8% of total income which means that charcoal accounts for approximately one percent of total income, since wood fuels from non-forest areas are estimated to be of minor importance. The charcoal income figures for Africa are similar to the global figures. The income share from charcoal is thus considerably higher in this study (12.5% for charcoal production only, see Figure 5) compared with the findings of Angelsen et al. (2014). That charcoal income is found to be more important for households in this study was though expected - first of all because Ghana is amongst the countries producing most charcoal and because the choice of study sites was based on the presence of charcoal production.

Comparing the results of this study with results from another African country, Schure et al. (2014) find that charcoal producers in DR Congo depend somewhat more on income from charcoal production. While Schure et al. (2014) find that charcoal production account for 38% and 75% of households' income in the two investigated study sites, this study finds households with low charcoal production income and households with high charcoal production income to have 7.3% and 34% of their income from charcoal production respectively. Limited knowledge about the income calculation method of the study by Schure et al. (2014) is though making this comparison less applicable. Since charcoal producers in the present study are found in all income quartiles the findings question the general assumption in literature that charcoal producers are the poorest

households in communities. Like in the studies by Khundi et al. (2011) and Schure et al. (2014), the present study finds some correlation between higher total income and charcoal income. Even though no significant difference between income quartiles' share from charcoal production is found, the absolute charcoal production values increase with income quartile. Moreover, when grouping charcoal producing households according to lowest and highest charcoal production income, then households with the highest charcoal production income both have a significantly higher income share from charcoal production as well as a significantly higher total income. Like in the study by Khundi et al. (2011) the present study also finds some correlation between engagement in charcoal production and lower income share from crop production. However, no significant correlation is found between lower livestock income share and charcoal production which was the case in the study by Khundi et al. (2011).

The Ghanaian study by Agyeman et al. (2012) about commercial charcoal producers further supports the findings of the present study indicating that some households are specializing in charcoal production and that charcoal income shares are higher for some ethnic groups, especially the Sissala people. Like Agyeman et al. (2012) find charcoal buyers income to vary considerably with some earning quite high amounts on trade, the present study finds similar results.

Even though some households engaged in charcoal production are headed by females the present study finds that there are more male headed households amongst producers than non-producers. This, along with the higher share of younger household heads amongst producers, corresponds well with descriptions of charcoal producers in existing literature. This study does however not find evidence that charcoal producers are less educated than non-producers. Likewise, the present study finds no clear correlation between dependence on charcoal income and remoteness of villages.

Comparing the results of this study with the results from another survey that uses more or less the same methodology at another site in Brong-Ahafo not far from the study sites of the present study, ref. Hansen et al. (2015), total net income is somewhat lower for all income quartiles. However, the observed difference can partly be explained by the fact that incomes in Hansen et al. (2015) are PPP (Purchasing Power parity) adjusted. If the same PPP conversion factor was used for incomes in this study, the values (except for

income quartile 4) would be a bit higher than incomes in Hansen et al. (2015). Income sources are categorized differently in the present study than in the study by Hansen et al. (2015), but still comparisons can be made to some extent. Looking at income from crop production for instance, the clear tendency that richer households are more dependent on crop production is not found in this study, since the richest group of households is less dependent on crop production than the other income quartiles. Furthermore, regarding business income the pattern of highest dependency for poorer people is reverse in the present study, where business is more important for richer income quartiles. Income from livestock is generally smaller in the present study, whereas income from wage work on the other hand generally is higher, especially for households with higher incomes. Taken into consideration that environmental products are categorized differently in the study by Hansen et al. (2015), the same pattern of higher dependency amongst poor households are found in the present study, especially if only looking at unprocessed environmental products. However, including charcoal production and processed environmental products as an environmental income will counterbalance the differences somewhat.

Comparing the overall socioeconomic characteristics of households in this study with other findings from Ghana there are some differences worth mentioning. These differences concern the age and sex of household heads as well as the size of households, where Pouliot & Treue (2013) presents somewhat lower figures for ages of household heads (46.3 - 50.4 years) and a lower share of females being head of the household (2.5% - 11.7%). Furthermore, the sizes of households in the present study are smaller than in the study by Pouliot & Treue (2013) (5.1 – 5.8). Even though geographical differences might cause these variations the earlier mentioned occasional difficulties in finding respondents might have had an influence on the results.

6.2 Limitations and weaknesses of the study

6.2.1 Underreporting of income and unit of analysis

It must be assumed that some underestimation of income has taken place in the present household survey. Some respondents might tend to underestimate income for several reasons of which time is an important factor. During the interview it was often observed

that people had forgotten about certain incomes because of the rather long recall period of one year. This source of error could though in some cases be minimized by using interview techniques to improve respondents' memory. The consumption of poultry or remittances/gifts received throughout the year was for instance difficult for respondents to remember, but by referring to special occasions like Easter or Christmas, the respondents were suddenly able to come up with some figures. Another issue related to this is that villagers had a hard time estimating how often they collected some of the environmental products recorded in the survey (e.g. leaves and mushrooms). In addition to this, many villagers did not recognize these products as an income source worth talking about. The amount of these products is therefore likely to be somewhat underestimated. Due to the extent of the interview (usually more than an hour) respondents might also have been tempted not to report all incomes. However, this risk was minimised due to the prior consent from respondents which was based on information about the expected duration of the interview among other things.

What is also worth remembering in a study like this is that income and income sources can vary from year to year. This study solely estimates income from year 2016 and therefore no conclusions can be made about changing incomes in the study areas. However, in order to clarify whether the income in 2016 was exceptionally different from previous years, questions regarding shocks have been addressed on village level at the study sites. Generally, villagers expressed that a drought in 2016 particularly affected the maize harvest. To what extent the registered incomes were influenced by this is hard to tell, since market prices also change according to supply and demand. Nevertheless, it is likely that some households have had a smaller income this year due to this. Looking at income in only one year also means that the possible dynamics in charcoal production and trade cannot be identified.

Another important factor likely to cause underestimation of incomes is the fact that all people in the household were not necessarily present at the time of the interview. The household head and his wife (the only persons required as respondents) are unlikely to account for all household members' income generating activities either because they do not know about some activities or because they do not remember. Furthermore, it can be discussed whether a household as the unit of analysis results in optimal income registra-

tions. The European/Western way of looking at a family might not be the same as in rural Ghana, where family members possibly tend to be more individualized. The husband in a household might for instance have his individual financial responsibilities (such as housing and school fees) which are quite different than the wife's financial responsibilities (typically food). Whatever they earn besides this might be kept unsaid. The criteria of both interviewing the household head and his wife can therefore have resulted in strategic answers from the respondents. A husband might not want to reveal towards his wife how much exactly he earned from a particular type of income activity, and the same goes for the wife. This issue is something that was observed in the field, and this might have caused some twisted estimations or underestimations especially in the recordings of "own business". It was also noticed that some people were not willing to say how much they got in salary. In such cases the enumerators did an estimation based on knowledge about standard wages according to the type of work in question. When this is said, the strategy of interviewing both the husband and the wife also has some positive effects since it leads to a better recall for respondents and a higher number of income generating activities registered in the survey. Interviewing all members of a household separately, would however also be a time consuming and logistically challenging task.

The risk of strategic answers from respondents includes more aspects than the above mentioned. Lund et al. (2011) for instance mention fear of robberies and political/economic sanctions leading to strategic answers. They further argue that others might try to avoid appearing wealthy due to the obligations and responsibilities towards more poor people or due to a desire for economic aid. As earlier mentioned, much effort has been put into explaining the purpose of the study and assuring anonymity in order to minimize the mentioned risks. However, the focus on presenting the study in a clear and appealing way does not necessarily eliminate the risk of underestimations. The presence of illegal income generating activities makes some questions in the survey particularly sensitive which increases the likelihood that respondents lie about their incomes. As stated by Hansen et al. (2015), chainsaw lumbering is a widespread activity in Ghana, and due to the illegality of this act people might not be open about how they benefit from the business. However, illegal chainsaw lumbering activities are not considered a

major problem in the study area. The fear of disclosing these activities is therefore likely only to cause minor underreporting of incomes.

6.2.2 Lacking information about capitals

Apart from estimating the economic importance of charcoal income for households the goal of this study was to explain which factors determine if a household earns from charcoal or not. The capitals of the livelihood framework were to provide a conceptual framework for this. As described in chapter 2, a full livelihood study includes an analysis of the five capitals (natural, physical, financial, human, and social). In this study compromises had to be made along the way, which means that only some aspects of the livelihood framework have been treated. Measuring natural capital turned out to be especially challenging. The amount of land that households own is maybe the simplest way to measure natural capital, but since villagers in the selected study sites do not formally own land, this measurement was not made. As indicated in the literature review charcoal producers have been characterised as people with limited agricultural capacity including area of land owned. The rationale for measuring households' land holding was thus to examine whether there is a connection between land holding and charcoal income. Likewise no recordings of tree resources (densities of trees in and around villages) were made. Some information was collected through focus group meetings and semi-structured interviews regarding availability of trees, but the information obtained could not form the basis for an adequate analysis.

Furthermore, it can be discussed whether the assets in Table 12 give a good indication of households' wealth and income generating opportunities. This concern is based on the fact that some of the assets were found to be commonly owned items for households while other items were only owned by a few. It can therefore be argued that more emphasis should have been put into the selection of items (e.g. by including villagers in the selection of items in the initial stage of fieldwork). This does however not mean that all the items analysed in this study are irrelevant to measure, but merely that some items might have been more suitable. Alternatively, it can be argued that resources should have been spent differently, the time used on these questions during interviews taken into consideration. Similar, an improved characterization of charcoal producers could maybe have been achieved if villagers were more included in the initial formation of the

questionnaire. It could for instance have been a good idea to arrange a focus group meeting in a village where pre-testing of the questionnaire was done.

In the ideal study more information should have been gathered about villagers' access to financial capital. Questions regarding savings were however decided not to be included in the survey since this is a very sensitive issue in the study areas. If including such questions people could be unwilling to participate, lie or feel uncomfortable during the interview. Because of these likely scenarios this aspect was excluded from the survey. Furthermore, as indicated earlier, more focus should have been directed to the investigation of access to loans and other financial arrangements for crop production and charcoal production in villages.

Also some elements of human capital have not been analysed in this study. As described in chapter 2, education is only one aspect of human capital, where *skills* and *health* are other relevant aspects. This could for instance be addressed by asking respondents how they got training in or how they learned to produce charcoal and if there are specific tasks which require external assistance. Addressing such questions might also facilitate a more thorough analysis on migrants' role in charcoal production now that indigenous inhabitants of communities have engaged in charcoal production.

6.2.3 Valuation methods and categorization of products

The valuating of some environmental products was found to be challenging. As described in section 3.2.2, the WTP valuation method was only used to a limited extend, since enumerators struggled to make people valuate non-marketed products. To overcome this issue fixed prices, used e.g. for wild leaves, might however not be the most optimal method to use, since it is likely that prices for non-marketed products vary from village to village due to the local supply and demand. The fixed prices for these non-marketed products had kilograms and grams as unit of measurement which made it difficult to estimate amounts consumed. It is hard to tell how the fixed prices have influenced the results, since local prices might be higher or lower according to village and demand of specific varieties of plants. An issue related to this is the categorization of products. First, too few product categories made it challenging to check some of the prices when doing data checking. Secondly, environmental products harvested from the wild might not actually be from the wild. Fruits, especially mango, which is a wide-

spread and popular fruit in the study area, along with medicinal plants were consequently recorded under the environmental product category even though many of these trees and plants are much likely to be planted or managed by the respondents. This may thus have led to an overestimation of the income share from environmental products. Income from high concentrations of planted fruit trees (considered plantations) were though recorded under crops and thereby a part of the agricultural income. However, if income from some environmental products was to be moved to the category of crop production, this would not change the fact that charcoal is the second most important income source for households.

6.3 Recommendations and further research

Based on the findings from semi-structured interviews and focus group meetings it is clear that there are some challenges related to a continual level of charcoal production in the future since villagers generally express that the availability of trees is declining. However, this study does not investigate the sustainability of charcoal production and can therefore not be used for advising decision makers in whether regulation is needed in the production or not. The results presented in this study substantiate that charcoal production makes an important income source for many households in charcoal producing areas. If regulations are to be made it is therefore important to ensure that the affected communities will have alternative income sources to cover lost income from charcoal production.

The results of this study show that the richer part of the respondents have higher shares of income from charcoal. However, when it comes to dependency, this is an issue complicated by the earlier mentioned circumstances (see section 5.2.4) suggesting that households with low charcoal production income might face economic difficulties in part of the year without the possibility of producing charcoal. Furthermore, it can be argued that the poorer you are the more vulnerable you are when loosing even smaller parts of your income. A ban on charcoal production might thus remove the subsistence foundation for households that, for part of the year, have little other choice of income sources. Besides, experience from other African countries shows that banning charcoal production has not been successful (Mugo & Ong, 2006; Mazimpaka 2014; Zulu & Richardson 2013).

As already mentioned, villagers expressed that 2016 was a bad maize-year due to drought. A study over several years is therefore recommended as it will show how people's priorities change with climatic variations along with other shocks or trends. It might also strengthen the findings suggesting that charcoal production is an important buffer in times of crisis and thus an important part of people's livelihood strategies. Relevant to future research is also to gather information about how long charcoal has been produced in the villages examined in this study. Such information could give an indication of what role time plays as well as the sustainability of charcoal production.

One of the aspects that showed to be decisive when it comes to social capital is the matter of CUGs. The results of the present study show that households with high charcoal production income and charcoal business income have higher scores on membership in CUGs. Improved bargain power, credit facilities and transport/market access are amongst some of the advantages that producer groups can provide (Pouliot & Elias, 2013). Establishing charcoal producer groups/cooperatives could therefore potentially increase charcoal producing households' earnings from charcoal. Even though such benefits were not directly given as reasons for joining CUGs in the present study, the majority of members state that the CUGs have a positive effect. Furthermore, the most given reason for joining (the social aspect - meeting people, working together, fear of exclusion, etc.) is a rather broadly defined category that does not reveal the details of benefits.

Network and cooperation might also be of importance when it comes to charcoal transport options for households. Since households with high charcoal income to a larger extend are found to sell charcoal outside the village it could be relevant to examine in more detail how they have access to transport facilities. This aspect is partly examined in section 5.2.3 where ownership of e.g. tractors and cars are evaluated. The higher rates of these assets for high charcoal production income households and charcoal business income households are not convincing (not statistically significant in most cases), but this might be because other transport vehicles or transport arrangements not investigated in the study are used. Furthermore, it is likely that the CUG's are playing a role as well. As one of the potential benefits of cooperatives is better transport and market access for

members, establishments of such groups might increase the profit of charcoal production.

Also microfinancing facilities, which can provide poor households with loans for small-scale business activities, have been found to reduce poverty (e.g. Addae-Korankye, 2012; Kasali, Ahmad, & Lim, 2016). Since traders were said to pre-finance producers in some of the study sites, microfinancing arrangements could thereby provide needed cash (now provided by traders) for producers and potentially improve small scale producers' profit. As pointed out by Obiri et al. (2014), there is also room for improving energy efficiency at charcoal production sites. For households with little access to credit, investments in improved technology might be out of reach or not of first priority. Microfinancing could maybe be a mean to overcome this barrier. Also CUGs could here be a good platform for members to go together and invest in better production technologies.

When all this is said, it should be stressed that the mentioned recommendations regarding the establishment of cooperatives and microfinance arrangements first need to be backed up by additional research on transport, CUGs, and credit facilities in the study sites. This includes information about how the user groups in the selected study sites work and how they come into being. Such knowledge could help facilitate initiatives ensuring a more equal distribution of charcoal earnings amongst households.

7 Conclusion

This study contributes with new knowledge concerning the economic importance of charcoal income for rural households in a charcoal producing area in Ghana. The findings show that charcoal income on average constitutes 16% of households' income, thereby making charcoal income the second most important income source only surpassed by crop production. Furthermore, charcoal is an important source of cash income, since it on average makes up 25% of households' cash income. With 12.5% of households' income being from charcoal production compared to 3.2% from charcoal business and 0.3% from charcoal wage work, charcoal production is by far the most important type of charcoal income. Furthermore, 66% of households have charcoal income, where almost all of these households are charcoal producers, meaning that this income source is a livelihood activity for most villagers. The richest households are however found to have higher charcoal incomes both in absolute and relative terms. Furthermore, the findings suggest that only a smaller group of households has charcoal as a main source of income. There is thus a pattern that few households specialize in charcoal production and charcoal business, especially trading, and have high incomes as a result.

Regarding the characteristics of households with a charcoal income, the study shows that these households are found to have both younger household heads and a higher rate of males compared to households with no charcoal income. Furthermore, heads of households with charcoal income are more likely to be married and not belong to the dominant tribe in village compared to households with no charcoal income. The results do not show any significant correlation between charcoal income and education level. Neither do they show any clear association between charcoal income dependence and remoteness of villages. The results do however shows that households with high charcoal production income to a higher extend sell their charcoal outside the village. Charcoal producers with a high charcoal production income or a charcoal business income are also more likely to be member of a CUG compared to households with low charcoal production income. Finally, there is found no clear correlation between engagement in charcoal activities and assets even though households with charcoal business income have the highest scores on most assets.

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Appendix A: Village survey (questionnaire)

Name of enumerator	
Date *(yyyymmdd)*	

A. Geographic and climate variables

1. What is the name of the village?	
2. What is the name of district?	
2. What are the GPS coordinates of the village? (UTM format)	
3. What is the latitude of the village?	*degrees*
4. What is the longitude of the village?	*degrees*
5. What is the altitude (masl) of the village?	*masl*
6. What has been the average annual rainfall (mm/year) in the district during the past 20 years?	*mm/year*
7. What is the coefficient of variation in rainfall for the past 20 years? *(Note: To be filled in if data are readily available.)*	
8. What was the total rainfall in the village for the past 12 months? *(Note: To be filled in if data are readily available.)*	*mm/year*

B. Demographics

1. In what year was the village established?	
2. What is the current population of the village?	*persons*
3. How many households live currently in this village?	*households*
4. What was the total population of the village 10 years ago?	*persons*
5. How many households lived in the village 10 years ago?	*households*
6. How many persons (approx.) living here now have moved to the village in the past 10 years (in-migration)?	*persons*
7. How many persons (approx.) have left the village over the past 10 years (out-migration)?	*persons*
8. How many different tribes are living in the village? (list the codes separated by a comma) *Codes:1= Mo; 2=Dagarti; 3=Mossi; 4=Gonja; 5=Kokomba; 6=Frafra; 7=Brong; 8=Sissala; 10=Tsokosti; 11=Mamprusi; 12=Dagomba; 9=other, specify*	

C. Infrastructure

1. How many households (approx.) in the village have access to electricity (from public or private suppliers)?	*households*
2. How many households (approx.) in the village have access to (= use) piped tap water?	*households*
3. How many households (approx..) in the village have access to (=use) bole hole water?	*households*
4. How many households (approx.) have access to formal credit (government or private bank operating in the village)?	*households*
5. Are *informal* credit institutions such as savings clubs and money lenders present in the village? *Codes: 1=yes, 0=no*	*(1-0)*
6. Is there any health centre in the village? *Codes: 1=yes, 0=no*	*(1-0)*
7. Does the village have at least one road useable by cars during all seasons? *If 'yes', go to 9.* *Codes: 1=yes, 0=no*	*(1-0)*

8. **If 'no':** what is the distance in kilometers to the nearest road usable during all seasons?				*km*
9. Is there a river within the village boundaries that is navigable during all seasons? *If 'yes', go to 11.* *Codes: 1=yes, 0=no*				*(1-0)*
10. **If 'no'**: what is the distance to the nearest river that is navigable during all seasons?				*Km*
11. What is the distance from the village centre to the nearest …				
		1. km	**2. min**	***3. transport[1)]***
	1. district market			
	2. market for major consumption goods			
	3. market where agric. products are sold			
	4. market where charcoal is sold			

Codes: 1=foot, 2=bike, 3=motorbike, 4=donkey/ox cart (load on their bag), 5=tractor, 6=car/van, 7=truck/lorry, 8=bus, 10=3 wheel van, 9=other, specify

Please state here who the primary respondents are:	

Appendix B: Household survey (questionnaire and product list)

Enumerator

Name of enumerator	

Introduction and confidential statement

My name is …, from a research project called ”Property, Access and Exclusion along the Charcoal Commodity Chain in Ghana" (AX) which is a collaboration between Kwame Nkrumah University of Science and Technology, University of Ghana, Tropenbos International Ghana and University of Copenhagen. The aim of this survey is to investigate people's economic dependence on charcoal.
The information that you give us will be treated confidentially and we assure you anonymity. Later when the data has been analyzed we will make sure that the results will be given to your community.

“Do you have any questions about this research? Are you willing to take part in this interview? If you say yes, I will tick this box to indicate that I have read this information to you, that you understand and that you are willing to take part.”

1. Has this information been disseminated to the respondent and does he/she consent to participate in the interview? [Enumerators should use all means to make people understand the benefit to their community of participating in the survey.] *Codes:1= ye s, 0= no* If the household consent to participate then **mark the household ID** on your personal household ID list and proceed with the interview.	*(1-0)*
2. IF "No - does NOT want to participate" What is the reason that you don't want to participate in the interview? You should then go to the next household and start a new interview.	

A. Identification

1. Household ID	
2. Name of village	
3. Name of district	

B. Household and contact information

[Explain to the respondent]: In the following questions we will ask about the people of the household (people living under the same roof who exchange labour time without any payment and who "eat from the same pot"). It is important that you consider all the individuals that belong to and live the majority of the year in your household.

1. Please write the name of the household head (Household head here refers to the one who is managing the entire family now)	
2. Contact information of household head (mobile phone number if available)	

Respondents

1. Confirm that the primary respondent is household head by choosing "YES", otherwise "No" *Codes:1= ye s, 0= no* *If yes, go to 3.*	*(1-0)*
2. If he/she is not the household head, please write here name of the primary respondent:	
3. Please write here name of the secondary respondent : (if none, go to next section)	

Household head

1. How many years is the household head?	
2. Gender of household head	
3. Highest education level of household head 1=illiterate, 2=informal education, 3=basic education, 4=secondary school, 5=tertiary	
4. Was the household head born in this village? *If 'yes', go to 6.*	*(1-0)*
5. **If 'no':** how long has the household head lived in the village?	*years*
6. What is the marital status of household head? *Codes: 1=married; 2=unmarried , 3= divorced; 4= widow/widower; 5=refuses to answer*	
7. How long ago was this household formed (it can refer to the establishment of the first homestead - first wife)?	*years*
8. Does the household head belong to the largest tribe in the village?	*(1-0)*
9. Which tribe[1)] does the household head belong to?	

1) Codes:1= Mo; 2=Dagarti; 3=Mossi; 4=Gonja; 5=Kokomba; 6=Frafra; 7=Brong; 8=Sissala; 9=Tsokosti; 10=Mamprusi; 11=Dagomba; 12=other, specify

Household composition

1. How many members are there in total in your household?	
2. How many members of the household are under 15 years old?	
3. How many members of the household are 15-65 years old?	
4. How many members of the household are over 65 years old?	

C. Land

1. How ~~many acres~~ of cultivated land does your household have?	*acre*
2. How ~~many acres~~ of fallow land does your household have?	*acre*

D. House

1. What is the ownership of your house? [1)]	
2. What is the type of material of (most of) the walls? [2)]	
3. What is the type of material of (most of) the roof? [3)]	
4. How many rooms are in the house?	

1) Codes:1=own the house on their own; 2=own the house together with other household(s); 3=renting the house alone; 4=renting the house with other household(s); 5=family house; 6=other, specify:
2) Codes: 1=mud/soil; 2=wooden (boards, trunks); 3=iron (or other metal) sheets; 4=bricks or concrete; 5=reeds/straw/grass/fibres/bamboo; 6=other, specify:
3) Codes: 1=thatch; 2=wooden (boards); 3=iron (or other metal) sheets; 4=tiles; 5=other, specify:

E. Other assets

Please write how many units of the following assets the household own (if the respondent does not have the item in question then write 0).

Car/truck	
Motorcycle	
Bicycle	
Tractor	
Plough	
Wooden cart or wheelbarrow	
Mobile phone	
TV	
Radio	
Cassette/CD/VHS/VSD/DVD player	
Camera	
Stove for cooking (charcoal, gas)	
Refrigerator/freezer	
Furniture	
Gun/rifle	
Chainsaw	
Water pump	
Solar panel	
Solar light	
Laptop/computer	

F. Charcoal user groups

1. Are you or any member of your household a member of a charcoal user group? *If 'no', go to 12.*		*(1-0)*
2. What is the name of the user group?		
3. Does someone in your household normally/regularly attend the user group meetings/activities? *If 'no', go to 6.*		*(1-0)*
4. **If 'yes'**: in your household, who normally attends the meetings and participates in charcoal user group activities? *Codes: 1=only the wife; 2=both, but mainly the wife; 3=both participate about equally; 4=both , but mainly the husband; 5=only the husband; 6=mainly son(s); 7=mainly daughter(s); 8=mainly husband & son(s); 9=mainly wife & daughter(s); 10=other arrangements not described above*		
5. How many person days (= full working days) did the household members spend in total on charcoal user group activities (meetings, policing, joint work, etc) over the past 12 months?		*days*
6. Does your household make any cash payments/contributions to the charcoal user group? *If 'no', go to 8.*		*(1-0)*
7. **If 'yes':** how much did you pay in the past 12 months? *(Ghanaian Cedi)*		
8. Did your household receive any cash payments from the charcoal user group (e.g., share of sales) in the past 12 months? *If 'no', go to 10.*		*(1-0)*
9. **If 'yes':** how much did you receive in the past 12 months? *(Ghanaian Cedi)*		
10. What are your most important reasons for joining the charcoal user group? *If several reasons, **max state the three** most important.*	**Reason**	
	1. Increased access to wood for charcoal	
	2. Better tree management and more benefits in future	
	3. Access to other benefits, e.g., government support or donor programs	
	4. My duty to protect the tree resources for the community and the future	
	5. Being respected and regarded as a responsible person in the village	
	6. Social aspect (meeting people, working together, fear of exclusion, etc.)|	
	7. Forced by Government/chiefs/neighbours	
	8. Higher price for charcoal	
	9. Better quality of charcoal	
	10. Receipt of direct payments	
	11. Makes harvest of wood for charcoal production more efficient	
	12. Learn new skills/information	
	13. Reduce conflicts over resource	
	14. Other, specify:	
11. Overall, how would you say the existence of the charcoal user group has affected the benefits that the household gets? *Codes: 1=large negative effect; 2=small negative effect; 3=no effect; 4=small positive effect; 5=large positive effect.*		
12. **If you don't participate in a Charcoal user group,** why? *If several reasons, **max state the three** most important.*	**Reason**	
	1. No charcoal user group exists in the village	
	2. I'm new in the village	
	3. Charcoal user group members generally belong to other group(s) (ethnic, political party, religion, age, etc.) than I do	
	4. Cannot afford to contribute the time	
	5. Cannot afford to contribute the required cash payment	
	6. Charcoal user group membership will restrict my use of wood for charcoal production, and I want to use the wood as I need it	

	7. I don't believe the charcoal user group is very effective in managing the tree stocks	
	8. Not interested in the activities undertaken by existing charcoal user groups	
	9. Corruption in the charcoal user groups	
	10. Interested in joining but needs more information	
	11. Other, specify:	

G. Forest User Groups (FUG)

1. Are you or any person from your household a member of a Forest User Group (FUG)? *If 'no', go to 12.*		*(1-0)*
2. What is the name of the user group?		
3. Does someone in your household normally/regularly attend the FUG meetings/activities? *If 'no', go to 6.*		*(1-0)*
4. **If 'yes'**: in your household, who normally attends the meetings and participates in other FUG activities? *Codes: 1=only the wife; 2=both, but mainly the wife; 3=both participate about equally; 4=both, but mainly the husband; 5=only the husband; 6=mainly son(s); 7=mainly daughter(s); 8=mainly husband & son(s); 9=mainly wife & daughter(s); 10=other arrangements not described above.*		
5. How many person days (= full working days) did the household members spend in total on FUG activities (meetings, policing, joint work, etc) over the past 12 months?		*days*
6. Does your household make any cash payments/contributions to the FUG? *If 'no', go to 8.*		*(1-0)*
7. **If 'yes':** how much did you pay in the past 12 months? *(Ghanaian Cedi)*		
8. Did your household receive any cash payments from the FUG (e.g., share of sales) in the past 12 months? *If 'no', go to 10.*		*(1-0)*
9. **If 'yes':** how much did you receive in the past 12 months? *(Ghanaian Cedi)*		
10. What are your most important reasons for joining the FUG? If several, **max state the three** *most important.*	**Reason**	
	1. Increased access to forest products	
	2. Better forest management and more benefits in future	
	3. Access to other benefits, e.g., government support or donor programs	
	4. My duty to protect the forest for the community and the future	
	5. Being respected and regarded as a responsible person in the village	
	6. Social aspect (meeting people, working together, fear of exclusion, etc.)|	
	7. Forced by Government/chiefs/neighbours	
	8. Higher price for forest product	
	9. Better quality of forest product	
	10. Receipt of direct payments	
	11. Makes harvest of forest products more efficient	
	12. Learn new skills/information	
	13. Reduce conflicts over resource	
	14. Other, specify:	
11. Overall, how would you say the existence of the FUG has affected the benefits that the household gets from the forest? *Codes: 1=large negative effect; 2=small negative effect; 3=no effect; 4=small positive effect; 5=large positive effect.*		

12. **If you don't participate in FUG,** why? *If several reasons, **max state the three** most important.*	**Reason**	
	1. No FUG exists in the village	
	2. I'm new in the village	
	3. FUG members generally belong to other group(s) (ethnic, political party, religion, age, etc.) than I do	
	4. Cannot afford to contribute the time	
	5. Cannot afford to contribute the required cash payment	
	6. FUG membership will restrict my use of the forest, and I want to use the forest as I need it	
	7. I don't believe FUG is very effective in managing the forest	
	8. Lack of forest products	
	9. Not interested in the activities undertaken by existing FUGs	
	10. Corruption in FUG	
	11. Interested in joining but needs more information	
	12. Other, specify:	

Before proceeding, please first ask the respondent(s) which of the listed products in the "product list" the household has consumed/used or sold in the past 12 months.

H. Unprocessed products collected from the wild

1. What are the quantities and values of unprocessed products the members of your household collected for both own use and sale over **the past 12 months?**

Note: The quantities of unprocessed products from the wild which are used as inputs in making processed products with input from the wild should not be reported in the table below.

1. Product (*choose product from "product list")*	**2. Collected by whom?** [1)]	**3. Quantity collected (5+6)**	**4. Unit**[2)]	**5. Own use (incl. gifts given out)**	**6. Sold (incl. barter)**	**7. Price per unit**[3)]	**8. Type of market**[4)]	**9. Gross value (3*7)**	**10. Tran-sport/ marketing costs**	**11. Purch. inputs & hired labour**	**12. Net income (9-10-11)**

1) *Codes: 1=only/mainly by wife and adult female household members; 2=both adult males and adult females participate about equally; 3=only/mainly by the husband and adult male household members; 4=only/mainly by girls (<15 years);5=only/mainly by boys (<15 years); 6=only/mainly by children (<15 years), and boys and girls participate about equally; 7=all members of household participate equally; 8=person employed by and living with the household, 9=none of the above alternatives.*
2) *Codes: 1=grams, 2=kg; 3=tonnes; 4=pound, 5=litres, 6=tin, 7= cord, 8=mini bag, 9=maxi bag, 10=jumbo bag, 11=piece, 12=crate, 13=kia rhino, 14=kia, 15=kia mini, 16=motor king , 17=bale, 18=other, specify*
3) *Note: It is required to enter the price even if the product is not sold by the household. Make sure it is the same unit for quantity collected.*
4) *Codes: 1=sold within the village, 2= sold outside the village, 3= not sold on a market (NOTE- if both for own use and sold on a market remember to separate codes with a comma)*

I. Processed products (with input collected in the wild, including charcoal)

1. What are the quantities and values of processed products with input from the wild that the members of your household produced during **the past 12 months?**

1. Prod-uct (*choose product from "product list")*	**2. Who in the house-hold did the work?[1)]**	**3. Quantity produce d (5+6)**	**4. Unit[2)]**	**5. Own use (incl. gifts given out)**	**6. Sold (incl. barter)**	**7. Price per unit[3)]**	**8. Type of market[4)]**	**9. Gross value (3*7)**	**10. Trans-port/ marke-ting costs**	**11. Purch. inputs & hired labour**	**12. Payment s to the chief/ land owner**	**13. Net income excl. costs of inputs (9-10-11-12)**

1) *Codes: 1=only/mainly by wife and adult female household members; 2=both adult males and adult females participate about equally; 3=only/mainly by the husband and adult male household members; 4=only/mainly by girls (<15 years);5=only/mainly by boys (<15 years); 6=only/mainly by children (<15 years), and boys and girls participate about equally; 7=all members of household participate equally; 8= person employed by and living with the household, 9=none of the above alternatives.*
2) *Codes: 1=grams, 2=kg; 3=tonnes; 4=pound, 5=litres, 6=tin, 7= cord, 8=mini bag, 9=maxi bag, 10=jumbo bag, 11=piece, 12=crate, 13=kia rhino, 14=kia, 15=kia mini, 16=motor king , 17=bale, 18=other, specify*
3) *Note: It is required to enter the price even if the product is not sold by the household. Make sure it is the same unit for total quantity produced.*
4) *Codes: 1=sold within the village, 2= sold outside the village, 3= not sold on a market (NOTE- if both for own use and sold on a market remember to separate codes with a comma)*

J. Fishing and aquaculture

1. How much fish did your household catch during **the past 12 months**?

1.Which aquatic animal did your household catch[1)]	**2. Total catch (pieces) (3+4)**	**3. Own use (pieces) (incl. gifts given out)**	**4. Sold (pieces) (incl. barter)**	**5. Price per piece[2)]**	**6. Gross value (2*5)**	**7. Costs (inputs, hired labour, marketing)**	**8. Net income (6-7)**

1) Codes: 1= fish, 2= crab
2) Note: It is required to enter the price even if the product is not sold by the household.

K. Wage income

1. Has any member of the household had paid work **the past 12 months**?

Note: If the payment is (partly) in kind (e.g. helping in harvesting and get paid 10 kg of rice) you should estimate and write the monetary value of that.

1. Type of work[1)]	**2. Paid daily, weekly, monthly or one-off?**	**3. Quantity (i.e. number of days, weeks, months, one-off)[2)]**	**4. Wage rate (i.e. per day, per week, per month, or per one-off)[2)]**	**5. Total wage income (3*4)**

1) *Codes: 1=Bagging charcoal, 2=Loading charcoal, 3= Charcoal production, 4= Agriculture/plantation worker, 5= Forestry (logging, processing, transport, tree planting etc.), 6= Fishfarm worker/fishing, 7= Transport/driver, 8= Trade and marketing (not charcoal), 9= Construction/carpentry (bought input), 10= Repairer, 11=Mining/quarrying, 12=Manufacturing industry, 13=Service industry, 14=Government employment, 15=Tailor/shoe maker/hairdresser/similar, 16=Steelworker/goldsmith, 17=Domestic work (e.g. cook, servant, babysitter..in another home), 18=Guard/ranger, 19=Cook, 20=Road construction/maintenance, 21=Electrician, 22=Craftsman, 23=Teacher, 24=Other, specify*
2) *Unit must be consistent with the previous question*

L. Income from own charcoal business (trade and transport, NOT production)

1. Are you involved in any such business, what are the gross income and costs related to that business?

Note: If the household produces charcoal itself and has a charcoal production business, the income should not be reported under this table, but instead in box I (processed products).
Note: If the household is involved in several different types of business, you should fill in one column for each business.

	1. Business	**2. Business**	**3. Business**
1. What is your type of business?[1)]			
2. Gross income (sales, without deducting costs) [past 12 months] (Ghanaian cedi)			
Costs:			
3. Purchased inputs (fuel for transport not included)			
4. Hired labour			
5. Transport/fuel for transport and marketing cost			
6. Capital costs (repair, maintenance, etc.)			
7. Other costs			
8. Net income (2 -3-4-5-6-7)			

1) Codes: 1=middleman (person who knows where producers are, charge comission); 2=trader (buyer and seller of charcoal in community), 3=chainsaw opperator, 4=other, specify:

M. Income from own business (not environmental, agriculture or related to charcoal)

1. Are you involved in such business, and if so, what are the gross income and costs related to that business **the past 12 months?**
Note: If the household is involved in several different types of business, you should fill in one column for each business

	1. Business	**2. Business**	**3. Business**
1. What is your type of business?[1)]			
2. Gross income (sales, without deducting costs) [past 12 months] (Ghanaian cedi)			
Costs:			
3. Purchased inputs (fuel for transport not included)			
4. Hired labour			
5. Transport/fuel for transport and marketing cost			
6. Capital costs (repair, maintenance, etc.)			
7. Other costs			
8. Net income (2 - 3-4-5-6-7)			

1) Codes: 1=Food selling (bought input),; 2=other shop/trade; 3=agric. processing (bought input); 4=lodging/restaurant 5=carpentry; 6=landlord/real estate; 7=transport/driver; 8=renting out equipment; 9=tailor/shoe maker, hairdresser or similar; 10=herbalist /native doctor/midwife, 11=repairer, 12=steelworker/goldsmith, 13=brick making(with bought input); 14=quarrying; 15= contracted work (cleaning/maintenance); 16=brewing, 17=other, specify:

N. Income from agriculture (crops, including products from plantations and agroforestry)

1. What are the quantities and values of crops that the household has harvested and consumed/sold during **the past 12 months?**

Note: Remember to probe for and include small quantities of crops that are continuously harvested for subsistence uses.

1. Crops *(choose product from "product*	**2. Area of production** (*acre)*	**3. Total production (5+6)**	**4. Unit[1)]**	**5.Own use (incl. gifts given out)**	**6. Sold (incl. barter)**	**7. Price per Unit[2)]**	**8.Gross income (3*7)**

1) *Codes: 1=grams, 2=kg; 3=tonnes; 4=pound, 5=litres, 6=tin, 7= cord, 8=mini bag, 9=maxi bag, 10=jumbo bag, 11=piece, 12=crate, 13=kia rhino, 14=kia, 15=kia mini, 16=motor king , 17=bale, 18=other, specify*
2) *Note: It is required to enter the price even if the product is not sold by the household.*

2. What are the quantities and values of **inputs** used in crop production **the past 12 months** (this refers to agricultural cash expenditures)?

Note: Take into account all the crops in the previous table.

1. Crops *(choose product from "product list")*	**2. Seeds**	**3. Fertilizers**	**4. Pesticides/ herbicides**	**5. Manure**	**6. Irrigation**	**7. Hired labour**	**8. Hired machinery**	**9. Transport/ marketing**	**10. Payment for land rental**	**11. Other, specify:**

O. Income from livestock

1. What is the number of animals your household has now, and how many have you sold, bought, slaughtered or lost during **the past 12 months**?

1. Livestock	**2. Number of animals now**	**3.Sold (incl. barter), live or slaught-ered**	**4. Own use (incl. gifts given out)**	**5. Lost (theft, died,..)**	**6. Price per adult animal**	**10. Income (3+4)*6**
1. Cattle						
2. Goats						
3. Sheep						
4. Pigs						
5. Donkeys						
6. Ducks						
7. Chicken						
8. Guinea pigs						
9. Rabbit						
10. Grass cutter						
11. Turkey						
12. Guinea fowl						
13. Other, specify:						

2. What are the quantities and values of **inputs** used in livestock production during **the past 12 months** (cash expenditures)?

1. Livestock	**2. Medicines, vaccination and other veterinary services**	**3. Costs of maintaining barns, enclosures, pens, etc.**	**4. Hired labour**	**5. Other, specify:**
1. Cattle				
2. Buffalos				
3. Goats				
4. Sheep				
5. Pigs				
6. Donkeys				
7. Ducks				
8. Chicken				
9. Guinea pigs				
10. Rabbit				
11. Turkey				
12. Guinea fowl				
13. Other, specify:				

P. Income from livestock products

What are the quantities and values of animal products and services that you have produced during **the past 12 months**?

1. Product/service	**2. Production (4+5)**	**3. Unit[1)]**	**4. Own use (incl. gifts)**	**5. Sold (incl. barter)**	**6. Price per Unit[2)]**	**7. Gross income 2*6**	**8. Costs related to processing of product**
1. Milk							
2. Eggs							
3. Hides and skin							
4. Manure							
5. Other, specify							

1) Codes: 1=grams, 2=kg; 3=tonnes; 4=pound, 5=litres, 6=tin, 7= cord, 8=mini bag, 9=maxi bag, 10=jumbo bag, 11=piece, 12=crate, 13=kia rhino, 14=kia, 15=kia mini, 16=motor king , 17=bale, 18=other, specify

2) Note: It is required to enter the price even if the product is not sold by the household.

Q. Other income sources

1. Please list any other income that the household has received during **the past 12 months?**

1. Type of income	**2. Total amount received**
1. Payment for renting out land (if in kind, state the equivalent in cash)	
2. Compensation from logging or mining company (or similar)	
3. Remittances	
4. Support from government, NGO, organization or similar	
5. Gifts/support from friends and relatives	
6. Other, specify:	

R. Crisis and unexpected expenditures

Has the household faced any major income shortfalls or unexpectedly large expenditures during the past 12 months?

Event	**1. How severe?[1)]**	**How did you cope with the income loss or costs?[2)]**
1. Serious crop failure		
2. Serious illness in family (productive age-group adult unable to work for more than one month during past 12 months, due to illness, or to taking care of ill person; or high medical costs)		
3. Death of productive age-group adult		
4. Land loss (expropriation, etc.)		
5. Major livestock loss (theft, drought, etc.)		
6. Other major asset loss (fire, theft, flood, etc.)		
7. Lost wage employment		
8. Wedding or other costly social events		
9. Payment for sale of household products arrive later than expected		
10. Cattle invasion		
11. Other, specify:		

1) Codes severity: 0=no crisis; 1=yes, moderate crisis; 2=yes, severe crisis.
2) Codes coping:
1. Produced more charcoal
2. Engaged more in charcoal business (sale, transport, bagging, loading and wage work production)
3. Did extra casual labour work (not related to charcoal)
4. Produced more agricultural products
5. Spent cash savings / sold assets (land, livestock, etc.)
6. Harvested more products from the wild (not including charcoal)
7. Got assistance from friends and relatives
8. Got assistance from NGO, community org., religious org. or similar
9. Got loan from money lender, credit association, bank etc.
10. Tried to reduce household spending
11. Reduced number of meals taken
12. Borrowed against future earnings
13. Rented out land
14. Started new business (not related to charcoal)
15. Changed to different type of livestock
16. Changed cropping patterns or types of crops planted
17. Other, specify:

S. Seasonal importance of charcoal

1. Are there any periods of the year where income from charcoal (production/sale/transport) is the only or major income source? *Codes: 1=yes 0=no,*	*(1-0)*
2**. If yes**, what is the reason for this? *Codes: 1= there are no other income sources, 2= there are other income sources, but they are not sufficient to make a living, 3= there are other income sources from where I can make a living, but charcoal production is more profitable*	

T. Welfare perceptions and social capital

1. All things considered, how satisfied are you with your life over the past 12 months? *Codes: 1=very unsatisfied; 2=unsatisfied; 3=neither unsatisfied or satisfied; 4=satisfied; 5=very satisfied*		
2. Has the household's food production and income over the past 12 months been sufficient to cover what you consider to be the needs of the household? *Codes: 0=no; 1=reasonable (just about sufficient); 2= yes*		
3. Compared with other households in the village (or community), how well-off is your household? *Codes: 1=worse-off; 2=about average; 3=better-off*		
4. How well-off is your household today compared with the situation **5 years ago?** *Codes: 1=less well-off now; 2=about the same; 3=better off now* *If 1 or 3, go to 5. If 2, go to 6.*		
5. **If less well-off *or* better-off:** what is the main reason for the change? *If several reasons, max state the three most important.*	**Reason: Change in …**	
	1. income from charcoal (production, own business, wage work etc.)	
	2. access to wood for charcoal	
	3. access to other natural resources	
	4. land area for agric. production	
	5. crop failure/raiding	
	6. output prices (forest, agric,…)	
	7. income from off farm employment (not charcoal)	
	8. started a new business/lost or less business (not related to charcoal)	
	9. health status	
	10. cost of living (e.g., high inflation)	
	11. material assets, incl. house (gain or loss)	
	12. livestock (gain or loss)	
	13. family situation (e.g. loss of family member)	
	14. infrastructure (e.g. new road or deterioration of road)	
	15. Fire destroyed everything	
	16. education / increased knowledge	
	17. outside support (govt., NGO,..)	
	18. remittances	
	19. other (specify):	
6. Do you consider your village (community) to be a good place to live? *Codes: 0=no; 1=partly; 2=yes*		
7. Do you **in general** trust people in the village (community)? *Codes: 0=no; 1=partly, trust some and not others; 2=yes*		
8. Can you get help from other people in the village (community) if you are in need, for example, if you need extra money because someone in your family is sick? *Codes: 0=no;1= partly, 2=yes*		

Date, time, GPS:

Date:	*Time:*

GPS reference point of household (UTM format)	

Enumerator assessment of the household

Note: This is to be completed by the enumerator

1. During the last interview, did the respondent smile or laugh? *Codes: (1) neither laughed nor smiled (somber); (2) only smiled; (3) smiled and laughed; (4) laughed openly and frequently.*	
2. Based on your impression and what you have seen (house, assets, etc.), how well-off do you consider this household to be compared with other households in the village? *Codes: 1=worse-off; 2=about average; 3=better-off*	
3. How reliable is the information **generally** provided by this household? *Codes: 1=poor; 2=reasonably reliable; 3=very reliable*	
4. How reliable is the information on **charcoal collection/use** provided by this household? *Codes: 1=poor; 2=reasonably reliable; 3=very reliable, 4=the household had no income from charcoal*	
5. If the charcoal information is not so reliable (code 1 above), do you think the information provided overestimate or underestimate the actual use? *Codes: 1=underestimate; 2=overestimate; 3= no systematic over- or underestimation; 4=don't know*	

Product list

Note: The quantities of unprocessed products used as inputs in making processed products should not be reported under unprocessed products.

Unprocessed products from the wild:

1. Bush meat
2. Wild nuts (incl. shea nuts)
3. Wild vegetables
4. Wild leaves (rapping, spices etc.)
5. Medicinal plants (tree bark etc.)
6. Poles for building
7. Honey
8. Firewood
9. Bamboo
10. Rattan
11. Lianas and vines
12. Wild fruits (mango, banana etc. from the wild)
13. Dyes
14. Maakube
15. Raphia palm
16. Spear grass
17. Other:_____
18. Other:_____
19. Other:_____
20. Other:_____

Processed products with input from the wild:

1. Charcoal
2. Palm wine
3. Baskets
4. Pottery
5. Bricks
6. Wild animal hide
7. Sawn timber
8. Musical instruments
9. Cooking utensil (mortor, pestel etc.)
10. Broom
11. Cataput
12. Furniture (wood, rattan, bamboo)
13. Wood craft
14. Shea butter
15. Other:_____
16. Other:_____
17. Other:_____
18. Other:_____

Crops and plantation products:

1. Rice
2. Maize
3. Millet
4. Sorghum
5. Yam
6. Cassava (tuber)
7. Cassava (flour)
8. Potatos
9. Plantain
10. Cocoyam
11. Beans
12. Mango
13. Cashew
14. Soybean
15. Cow pea
16. Ground nut
17. Tomato
18. Green pepper
19. Pepper (chili)
20. Cabbage
21. Cucumber
22. Okro
23. Carrot
24. Onion
25. Lettuce
26. Oil palm
27. Citrus
28. Avocado (pea)
29. Watermelon
30. Pawpaw
31. Banana
32. Apple
33. Sunflower
34. Cotton
35. Pineapple
36. Plantation trees (for wood)
37. Other:_____
38. Other:_____
39. Other:_____
40. Other:_____

Appendix C: Interview guide – focus group meetings

All information in this survey should be gathered during a focus group meeting in each village.

A. List: all income generating products produced or collected in the village, the ways in which villagers earn money from charcoal, and important employment/migration opportunities.

This is done in order to make sure that all important products and incomes in the village can be recorded in the household survey which will be conducted after the village survey. After the list has been made the villagers will be asked to select the most important products in a ranking exercise (see ranking section in PRA methods guide).

1. Agricultural products (crops):

2. Unprocessed products harvested from the wild:

3. Processed products (where input is collected in the wild):

4. Fishing/aquaculture:

5. Ways in which you can earn money from charcoal:

6. Employment/migration opportunities

B. Seasonal calendar *(see "PRA method guide")*

Based on the selected most important products and employment opportunities from the section above a seasonal calendar is made shoving income and expenditures along with activities.

C. Environmental resource base (products harvested from the wild)

The questions should be asked for each of the categories in turn (i.e. column by column, and not row by row).

	1. product	2. product	3. product	4. product	5. product
1. What are the most important products[1] for the livelihood of the people in the village? *(record name of product)*	Wood for charcoal				
2. Where do you collect the products?					
2. How has availability of the products changed over the past 5 years?					
3. If the availability has **declined**, what are the reasons?					
4. If the availability has **increased**, what are the reasons?					
5. What would be most important to increase the benefits (use or income) from the products?					

1) "Most important" is defined as the most important for the wellbeing of the village, whether it be through direct use in the home, or through sale for cash, or both.

E. Charcoal user groups

1. Existence of charcoal user groups.

1. How many charcoal user groups are there in the village?	

2. Information about each charcoal user group (use one column per user group)

		Group 1	Group 2	Group 3
1. When was the group formed? *(yyyy)*				
2. How was the group formed? *Codes: 1=local initiative; 2=initiative from NGO; 3=initiative from government, e.g., Forest Department; 4=other, specify:*				
3. Is the user group's main purpose related to the management of a particular area?		*(1-0)*	*(1-0)*	*(1-0)*
4. How many members are there in the group?				
5. How many times per year does the user group have meetings?				
6. Does the group have a written management plan?		*(1-0)*	*(1-0)*	*(1-0)*
7. What are the main tasks of the charcoal user group? *Select as many as appropriate: 1-0 code*	1.Setting rules for use	*(1-0)*	*(1-0)*	*(1-0)*
	2. Monitoring and policing	*(1-0)*	*(1-0)*	*(1-0)*
	3. Management	*(1-0)*	*(1-0)*	*(1-0)*
	4. Harvesting wood for charcoal	*(1-0)*	*(1-0)*	*(1-0)*
	5. Selling charcoal	*(1-0)*	*(1-0)*	*(1-0)*
	6. Education/extension support	*(1-0)*	*(1-0)*	*(1-0)*
	7. Savings and credit	*(1-0)*	*(1-0)*	*(1-0)*
	8.Woodlot establishment	*(1-0)*	*(1-0)*	*(1-0)*
	9. Other, specify:	*(1-0)*	*(1-0)*	*(1-0)*

8. Has any development project been implemented in the village over the past 5 years using proceeds from the charcoal user group?	*(1-0)*	*(1-0)*	*(1-0)*
9. Has anyone in the village been violating the rules of the user group over the past 12 months? *If 'no', go to 13.*	*(1-0)*	*(1-0)*	*(1-0)*
10. **If 'yes'**: did the user group impose any penalties on those violating the rules?	*(1-0)*	*(1-0)*	*(1-0)*
11. If 'yes': what type of penalties? *Codes: 1=fee (cash payment); 2=returning collected products; 3=labour (extra work); 4=exclusion from group; 5=warning; 9=other, specify:*			
12. Which group of charcoal users has most commonly violated the rules over the past 5 years? *Codes: 1=members of the user group; 2=non-user group members in the village; 3=people from other villages; 9=other, specify:*			
13. Overall, on a scale from 1-5 (1 is highest, 5 is lowest) how effective would you say that the user group is in ensuring sustainable and equitable use of wood?			

Note: Any charcoal user groups in the village should be further discussed in the village narrative

F. Forest User Groups (FUG)

1. Existence of forest user groups (FUG).

1. How many forest user groups (FUG) are there in the village?	

2. Information about each FUG (use one column per FUG).

		1. FUG1	*1. FUG2*	*1. FUG3*
1. When was the group formed? *(yyyy)*				
2. How was the group formed? *Codes: 1=local initiative; 2=initiative from NGO; 3=initiative from government, e.g., Forest Department; 4=other, specify:*				
3. Is the FUG's main purpose related to the management of a particular forest area or of particular forest product(s)? *Codes: 1=area; 2=product(s); 3=both*				
4. If for a product (code 2 or 3above), what is the (main) product?				
5. How many members are there in the group?				
6. How many times per year does the FUG have meetings?				
7. Does the group have a written management plan?		*(1-0)*	*(1-0)*	*(1-0)*
8. What are the main tasks of the FUG? *Select as many as appropriate: 1-0 code*	1. Setting rules for use	*(1-0)*	*(1-0)*	*(1-0)*
	2. Monitoring and policing	*(1-0)*	*(1-0)*	*(1-0)*
	3. Silviculture & management	*(1-0)*	*(1-0)*	*(1-0)*
	4. Harvesting forest products	*(1-0)*	*(1-0)*	*(1-0)*
	5. Selling forest products	*(1-0)*	*(1-0)*	*(1-0)*
	6. Tree planting	*(1-0)*	*(1-0)*	*(1-0)*
	7. Tourism (i.e. maintaining tourist infrastructure; guiding tourists etc.)	*(1-0)*	*(1-0)*	*(1-0)*
	8. Education/extension support	*(1-0)*	*(1-0)*	*(1-0)*
	9. Other, specify:	*(1-0)*	*(1-0)*	*(1-0)*
	10. Savings and credit	*(1-0)*	*(1-0)*	*(1-0)*

11. Woodlot establishment	*(1-0)*	*(1-0)*	*(1-0)*
9. Has any development project been implemented in the village over the past 5 years using proceeds from the FUG?	*(1-0)*	*(1-0)*	*(1-0)*
10. Has anyone in the village been violating the rules of the FUG over the past 12 months? *If 'no', go to 14.*	*(1-0)*	*(1-0)*	*(1-0)*
11. **If 'yes'**: did the FUG impose any penalties on those violating the rules? *Codes: 1=fee (cash payment); 2=returning collected products; 3=labour (extra work); 4=exclusion from group; 5=warning; 9=other, specify:*	*(1-0)*	*(1-0)*	*(1-0)*
12. **If 'yes'**: what type of penalties? *Codes: 1=fee (cash payment); 2=returning collected products; 3=labour (extra work); 4=exclusion from group; 5=warning; 9=other, specify:*			
13. Which group of forest users have most commonly violated the rules over the past 5 years? *Codes: 1=members of FUG; 2=non-FUG members in the village; 3=people from other villages; 9=other, specify:*			
14. Overall, on a scale from 1-5 (1 is highest, 5 is lowest) how effective would you say that the FUG is in ensuring sustainable and equitable forest use?			

Note: Any FUGs in the village should be further discussed in the village narrative.

G. Risk

1. Has the village faced any of the following crises over the past 12 months? *Codes: 0=no; 1=yes,moderate crisis; 2=yes, severe crisis*	1. Flood and/or excess rain	
	2. Drought	
	3. Wild fire (in crops/ forest/grasslands etc)	
	4. Widespread crop pest/disease and/or animal disease	
	5. Human epidemics (disease)	
	6. Political/civil unrest	
	7. Macro-economic crisis	
	8. Refugee or migration infusion	
	9. Other, specify:	
	10. Wildlife predation on livestock	
	11. Conflicts over forest resources (theft)	
	12. Land conflicts within village	
	13. Bridge/road washed out	
	14. Harassment from forest officials	
	15. Cattle invasion	

C. Wages and prices

1. What was the typical daily wage rate for unskilled agricultural/casual adult **male/female** labour during the **peak/slack** season in this village over the past 12 months? *(Cedis/day)*		**Male**	**F**
	Peak	1.	2.
	Slack	3.	4.
2. What is the main staple food in the village? *(code-product)*			
3. What was the price of a kg of the main staple food during the past 12 months **before** and **after** the main agricultural harvest? *(Cedis/kg)*		**1. Before harvest**	**2. After**
4. What is the annual lease of one hectare of good agricultural land in the village (i.e., not degraded, not too steep, and suitable for common crops, and within 1km of the main road or settlement) *(Cedis/hectare)*			

Appendix D: Interview guide - semi-structured interviews

Land tenure:

1. How would you describe villagers' access to land?
2. Do people have the right to use land freely or do people need permission to cultivate land?
3. If permission is needed, who gives the permission and under which conditions?
4. Are there differences in access to land between groups of villagers (migrants, women etc.)?
5. How prevalent is it for villagers to have secure land title? - Do some people have the right to sell land or is it the chief only (belonging to the stoll)?
6. Are there any plantations in the village? If yes, how are the land rights to this land?

Tree tenure:

1. Does everybody need to have permission to access tree resources or is it only some groups - migrants?
2. Who gives the permission and what are the payments?
3. Have there been any conflicts between migrant charcoal burners and indigenous people? If yes, elaborate which conflicts
4. Have there been any bans of charcoal production in the village or increasing of the share of revenues to local authorities?
5. Have threats been made of bans or payment shares?

Management related to charcoal production:

1. Are there any local rules or customs related to management of trees used for charcoal production? If yes, list them
2. Who enforce the rules /moral codes?
3. How are the rules made?
4. What happens if you violate them, and who punishes the people who violate the rules?

Other important environmental products:

1. Are there customary or government rules regulating the use of other important products harvested from the wild?
2. Are the rules enforced/ respected by the members in the village?
3. Do the villagers require any permission to harvest the product? Who gives the permission?
4. Does the user have to pay for the permission? Who has to pay? How much and which groups have to pay?