From Bush Yams to Kola Nuts:

The Role of Non-Timber Forest Products (NTFPs) in Rural Livelihoods Around the Gola Rainforest National Park, Sierra Leone.

Thomas Meijer | Wageningen University | April 2020

Master Thesis

In partial fulfillment of the requirements for a Master International Development Studies (MID)

Development Economics Group (DEC)

For Wageningen University and Research

Title: From Bush Yams to Kola Nuts: The Role of Non-Timber Forest Products (NTFPs) in Rural Livelihoods Around the Gola Rainforest National Park, Sierra Leone.

Cover photograph: taken by the author; "*Fawei* seed found in the forest in Malema chiefdom".

Date: 10 April 2020

By: Thomas Meijer

Registration number: 950906-568-040

Course code: DEC-80436

Supervisors

dr.ir. MJ (Maarten) Voors

Associate Professor Development Economics Group

Wageningen University and Research

M (Mandy) Malan MSc

PhD Candidate Development Economics Group

Wageningen University and Research

P (Paul) Hofman MSc

PhD Candidate Development Economics Group

Wageningen University and Research

Abstract

Non-timber forest products (NTFPs) have received a lot of attention from researchers and policymakers in the past three decades for their potential as a conservation and development tool. So too in Sierra Leone, where local communities living around the Gola Rainforest National Park (GRNP) frequently collect NTFPs. Yet, little is known about the exact role that these products play in local livelihoods. This thesis explores the function of NTFPs in consumption, income generation and as a social safety-net. The research employs mixed methods by primarily combining quantitative cross-sectional data from a random sample of households around the GRNP with qualitative data gathered during fieldwork and taken from secondary sources. The data are used to give an overview of the types of NTFPs, where they are found, who uses them and for what purpose. Next to this descriptive approach, multiple regression analysis is employed to find correlations between covariate and idiosyncratic shocks to households and the collection and sale of NTFPs. The results show that most households collected and consumed NTFPs as food, medicine and building materials, though there is a lot of heterogeneity in the use of different NTFPs and the frequency of their collection. A third of households sold NTFPs, indicating that the income generating function plays a mostly complementary role for only a subset of households. The regression analysis shows a negative correlation between covariate shocks and engagement with NTFPs. Only when considering NTFP categories separately, collection of certain NTFPs is significantly positively correlated idiosyncratic shocks, while the sales of some NTFPs is negatively correlated with these shocks. Overall, households tend to rely on borrowing money or selling assets to deal with shocks, with only a seemingly limited or no role for NTFPs.

Keywords: non-timber forest products (NTFPs), livelihoods, consumption, income generation, social safety-net, covariate and idiosyncratic shocks, conservation, Gola Rainforest, Sierra Leone

Table of contents

List of tables

List of figures

Table of appendices

List of abbreviations

CSSL	Conservation Society of Sierra Leone
FEC	Forest Edge Community
FUG	Forest User Group
GRC	Gola Rainforest Conservation LG
GRNP	Gola Rainforest National Park
MAFFS	Ministry of Agriculture, Forestry and Food Security
NGO	Non-Governmental Organization
NTFP	Non-Timber Forest Product
OLS	Ordinary Least Squares
PEN	Poverty Environment Network
REDD	Reduce Emissions from Deforestation and forest Degradation in developing countries
RSPB	Royal Society for Protection of Birds

Acknowledgements

Writing this thesis was both enjoyable, frustrating and at times all encompassing, but I'm happy to have produced such a detailed account of NTFPs and potentially contribute something to the work done by GRC and local communities living around the GRNP. It took 8 months, but then you also get something (which has started to resemble a book according to my supervisor).

I want to thank Maarten Voors, Mandy Malan and Paul Hofman for supervising me. They supported me all the way from drafting my first proposal to making last minute arrangements for my fieldwork. Maarten always managed to get me excited (again) about NTFPs and my thesis, Mandy managed to get me to Sierra Leone within two weeks and assisted me there, and Paul helped me figure out the world of STATA and gave valuable feedback on my work. I also want to express gratitude for the funds that enabled me to undertake fieldwork and to all the lovely and engaged people that supported me during my stay in Sierra Leone. Special thanks to Bjorn and Alex for helping me settle in Kenema and drink the occasional beers together, to Fomba, Christian, Mohammed Swaray, Vandi Kamara, Paul Bockarie, Mohammed Kamara and all the other amazing staff at GRC that do great work and assisted me with my fieldwork, to Juliet, Richard and Fiona from the RSPB team who took me along on their visit to Malema chiefdom, and mostly to the Gola communities that welcomed me and told me about NTFPs.

Lastly, I want to thank my girlfriend Eva for putting up with me while I was absorbed by STATA and thesis writing. The song "NTFP tut mir weh" she wrote for me signified a significant portion of the feelings I had during the whole process. Her reading out the letters in my model specifications as words, and support in many other ways, always managed to cheer me up.

1. Introduction

Non-Timber Forest Products (NTFPs) have been heralded as a promising development and conservation ‘tool’ in tropical forest regions around the world. They range from various foods to medicinal plants, building materials and firewood, all of which can play an important role in supporting local livelihoods. Harvesting of these products requires little inputs, allowing often poor and rural communities to rely them for consumption, income generation and as a social safety-net. As people depend on NTFPs taken from the forest, this can also provide an incentive to conserve forests. Some researchers and practitioners have even argued that NTFPs can contribute to poverty alleviation (Shackleton et al. 2011). So too has the use of NTFPs been identified among communities living in and around the Gola Rainforest National Park (GRNP) in Sierra Leone. Most of these communities are poor, have little access to social services and have few income earning opportunities. Moreover, they rely on slash and burn rotational cropping, which poses a severe threat to forest cover in areas outside the GRNP boundary (RSPB 2015). Getting insight into the types of NTFPs collected and what livelihood function they fulfill, is vital information for authorities managing the forest landscape and those who aim to improve the wellbeing of communities that live there. An effective NTFP policy could be part of a range of measures that is employed to maintain forests and conserve biodiversity, while also having the potential to improve local livelihoods and communities’ resilience. From a broader perspective, exploring the function of NTFPs in livelihoods in the context of the GRNP contributes to understanding the diverse ways in which NTFPs are used by rural communities worldwide. This thesis, therefore, addresses the question what the role is of NTFPs in the livelihoods of communities living around the GRNP in Sierra Leone? To answer this question, the paper first explores what NTFPs are, what they are used for, who uses them, where they are found, and how abundant they are. The main focus in answering these questions will be on the consumption and income generation function of NTFPs. Subsequently, the paper uses correlation analysis to explore the question whether NTFPs are used to cope with negative shocks, which links to their social safety-net function.

Starting in the late 1980’s, NTFP research became more mainstream and enthusiasm about its potential peaked. This is signified by one of the first studies done on NTFPs in the region of the Gola Rainforest by Davies and Richards (1991). The authors make a first attempt at surveying the NTFPs used by local communities and provide some explanations of the function of these products in people’s livelihoods. The report provides a first exploration of NTFP species and their uses, which was essential to designing more recent NTFP surveys, such as the one used in the current study. Nevertheless, the survey results were not representative of the whole area around the GRNP and by now are potentially outdated, especially when considering a civil war raged in the Gola area between 1991 and 2002. A subsequent anthropological study by Leach (1994) provides a more profound account of the role of NTFPs in local livelihoods, though neither study empirically examines the consumption, income generation and social safety-net functions that NTFPs might fulfil. More recent studies have tried to explore the trade in, and estimate the economic value of, certain NTFPs in Sierra Leone, such as palm wine and medicinal plants (Lebbie and Guries 2002; Jusu and Sanchez 2013; 2014). Yet, these studies do not explicitly address how the trade affects the livelihoods of the communities from which NTFPs are sourced.

This study contributes to previous literature by giving a comprehensive, detailed and up-to-date account of the different NTFPs collected, consumed and sold by communities around the GRNP. Henceforth these activities will together be referred to as NTFP engagement. A distinction is drawn between the GRNP and the Gola Rainforest. The former is demarcated by a border inside which few people live and activities such as logging, mining and hunting are prohibited. The Gola Rainforest encompasses a larger area of forest, including both the GRNP and other swathes of rainforest populated by Mende communities. Contrary to previous research, this study uses a larger and representative sample of these communities to sketch an accurate picture of local engagement with NTFPs. Furthermore, this work goes beyond previous literature in that it explicitly analyses empirical evidence with regards to the social safety-net role played by NTFPs in local livelihoods within the context of Sierra Leone and the Gola Rainforest. Potentially even more important is the contribution that this work makes to the role of NTFPs in conservation and development policies employed by non-governmental, private sector and government organizations active in the Gola region. By deepening their understanding of the function of NTFPs in livelihoods, these organizations might be able to more effectively tailor their approach to NTFPs in order to achieve forest and biodiversity conservation goals, as well as helping local communities meet their basic needs.

The paper starts out by reviewing the general literature on NTFPs, focusing on the above-mentioned consumption, income generation and social safety-net functions (Section 2). Next, a theoretical and conceptual framework is set out that identifies a number of hypotheses that will be empirically tested regarding the shock coping function of NTFPs (Section 3). The subsequent section provides information on the study site, context and antecedent knowledge about NTFPs (Section 4). The following section sets out the methodology for the descriptive analysis, including the data used and analysis strategy, and presents the results (Section 5). Thereafter, the methodology for the correlation analysis is set out by describing the data used, operationalizing the different hypotheses and variables, and describing the empirical strategy. The results from the correlation analysis are presented in the same section (Section 6). Finally, the results, as well as the limitations, research implications and policy implications are discussed (Section 7), followed by the conclusions from this research (Section 8).

2. Literature review

2.1 What are NTFPs?

There has been an extensive debate in the literature with regards to what constitutes a NTFP. The term was coined by de Beer and McDermott (1989) in their report on the economic value of NTFPs in South-East Asia, where they define them as encompassing

> all biological materials other than timber which are extracted from forests for human use. These include foods, medicines, spices, essential oils, resins, gums, latexes, tannins, dyes, ornamental plants, wildlife (products and live animals), fuelwood and raw materials, notably rattan, bamboo, smallwood and fibres (24).

The authors make an explicit distinction between timber and NTFPs. The former is managed on an industrial scale for interests situated outside the forest. While NTFPs might also be managed and end up as inputs for large-scale urban-based industries, they are all "extracted using simple technologies by rural people living in or near forests" (ibid).

As noted in the introduction, starting in the 1980's there was an increased recognition of NTFPs as having potential to contribute to sustainable development and conservation. This idea has been central to how NTFPs are characterized. Nonetheless, scientific literature and documents produced by non-governmental organizations (NGOs) have used a wide variety of definitions. Shackleton et al. (2011a) build on work by Belcher and Vantomme (2003) in identifying the main points of contention. First, there is disagreement on how to distinguish between timber and wood. For example, are the stems, branches, and bark of trees or shrubs also NTFPs? Furthermore, more disagreements arise on whether to include fuelwood as a NTFP. According to the definition by de Beer and McDermott (1989), products can be (fuel)wood if they are collected on a small scale and for the benefit of rural communities. Nevertheless, some contradictions arise, for example large-scale fuelwood harvesting for urban use could also benefit rural communities, so it remains unclear whether fuelwood should then be excluded as a NTFP.

Second, some authors also include abiotic materials such as rocks, clay and sand, and ecosystem services such as carbon sequestration, in their definition. Nevertheless, a growing consensus has arisen over the exclusion of the former two as NTFPs. First, ecosystem services are now increasingly given their own classification as a service and not a product (Haines-Young and Potschin 2018). Second, abiotic products are not renewable resources thereby posing different problems around sustainable management (Shackleton et al. 2011a).

Third, some authors have questioned the definition of a forest (e.g only primary forest?), whether NTFPs can also come from biomes other than forests (e.g. grasslands), and if NTFPs can also be found among human impacted or modified ecosystems? Increasingly, a broad definition is used by researchers, which includes wild uncultivated flora and undomesticated fauna that are found in various ecosystems (including modified habitats, such as agroforests, fields and villages or urban green spaces). This definition goes beyond only habitat and landscape conservation which lies at the root of valuation and recognition of NTFPs and recognizes the importance of species conservation in human modified environments. Shackleton et al. (2011a) note that the latter is increasingly important, as most of the world's biodiversity is situated outside protected areas. According to the same line of thinking, wild plants might be "promoted by human presence, either by disturbance, removal of competition or predators, or by indirect additions (such as manure or water) from farming actions" (ibid, 10). Thinking about forests as having been affected by human activity for decades makes it harder to strictly differentiate between 'wild' and 'cultivated' forests or forest products. Problems with defining a certain product as a NTFP might arise when certain wild species become commercially domesticated and harvested.

Fourth, the question has been debated whether a product is still a NTFP if it is extracted on a large scale or its benefits do not accrue to local people. For example, markets might be developed for certain NTFPs, driven by urban migrants. According to the definition of de Beer and McDermott (1989), this would disqualify a product as a NTFP as benefits should accrue to local stakeholders. Similarly, Belcher and Vantomme (2003) note that the "real issue [regarding NTFPs] from the perspective of improving livelihoods (and this can also be an incentive for conservation) is the ownership and control of the resource" (167). Nevertheless, the issues of ownership and control could apply equally to minerals or agricultural resources, which are not defined according to these criteria. Therefore, Shackleton et al. (2011a) argue that even though a product is extracted on a large scale or controlled by outsiders, it remains valuable products from the forest so cannot easily be excluded from a definition.

There are few studies examining NTFPs in the context of Sierra Leone to this date. As noted, Davies and Richards (1991) undertook the first attempt to study the role played by the Gola Rainforest in people's livelihoods. They surveyed 12 villages around the northern part of the Gola Rainforest on forest products collected, with a focus on hunting and non-timber plant products.

While they devise several categories of forest products, such as building materials, forest foods and medicinal plants, they do not adopt a specific definition for NTFPs. Going beyond their work, Leach (1994) gives a more detailed and qualitative account of the role forest resources play in the local economy and social relations in Gola north. While she states the categories of forest products used by local communities (foods, building materials, fuelwood and medicine), she also does not adopt a specific definition. Neither do Jusu and Sanchez (2013; 2014) in their papers on medicinal plant trade in Sierra Leone or Lebbie and Guries (2002) in their study on palm wine trade in Freetown. The only study found using a clear definition was by Munro and Horst (2013), who note that "in a general sense, the term 'Non-Timber Forest Product' (NTFP) essentially refers to any subsistence or commercial item or material that is derived from a forest area, usually without actually felling trees" (5). Yet they adopt a more restricted definition, excluding bushmeat and giving wood-based products (e.g. poles, firewood and charcoal) a lesser focus, as they concentrate on what NTFPs could be commercialized without compromising forest and biodiversity conservation goals.

2.2 Role of NTFPs in livelihoods

There is a wealth of literature on the role that NTFPs play in livelihoods of the people collecting these products. While different studies use slightly alternative definitions (e.g. environmental income, forest products, wild products), they all identify three main roles for NTFPs in rural livelihoods: (i) supporting consumption, (ii) income generation and (iii) acting as a social safety-net (Angelsen et al. 2014; Belcher and Vantomme 2003; Shackleton et al. 2011b). Each role will be discussed in the subsequent sections.

2.2.1 NTFPs for consumption

NTFPs are often used for household consumption in rural communities to meet their everyday needs. Shackleton et al. (2011b) argue that much of subsistence use is influenced by the geographic constraints these communities face. Due to the rural and remote setting in which most NTFP users live, they often have limited access to markets. Long distances and poor road quality and access make transport costly, thus limiting the ability of rural people to participate in the market economy. The latter is often compounded by lack of access to finance, poor communication systems and limited information flows (for example see Kar and Jocobson 2012). In turn, this limits the financial resources and opportunities to purchase daily consumption items. All the while, other than the opportunity cost of labor, NTFPs are effectively free to extract from nearby forests. Food is often collected to meet nutritional needs, medicinal plants can be used for self-medication, a variety of raw materials are used for construction, and scrap wood is used as fuel (e.g. Shackleton and Shackleton 2002; Arnold 1995; Osemeobo and Ujor 1999; for an overview of different NTFPs found in Africa see Timko et al. 2010).

2.2.2 NTFPs as a source of income

The sale of NTFPs forms an important source of cash income for many rural and urban households and individuals in the Global South (Kamanga et al. 2008; Paumgarten and Shackleton 2009; Saha and Sundriyal 2011; Endama et al. 2016; Lepcha et al. 2018). NTFPs can allow households to diversify their income by combining NTFP extraction with other economic activities (Timko et al. 2010). Angelsen et al. (2014) use data from the Poverty Environment Network (PEN) collected by researchers in Latin America, Africa and Asia data, to estimate the role NTFPs play in incomes of rural communities throughout the Global South and find that the average share of household income from forests is 22.2%.[1] From this income, the most important source is fuelwood (35.2%), followed by food (30.3%) and structural and fiber products (24.9%). Lastly, they show that subsistence use of forest income plays a larger role in livelihoods of the poorest households, while higher cash income from forests is associated with richer households. These findings are corroborated by many other studies, for example Sander and Zeller (2007) who study the Marovay region of northwestern Madagascar and find that the better-off households generated roughly 50% more cash-income than the poorest. Another example is a study by Paumgarten and Shackleton (2009) who look at two villages in two poor regions in South Africa and find that poor households trade in low-return products with low skill requirements. While poor households use NTFPs as a livelihood stabilizer and safety-net, richer households are involved with more high return products. The authors suggest that wealthier households may have more access to capital, transport and markets, thus enabling them to earn more from NTFP commercialization as a primary livelihood activity.

2.2.3 NTFPs as a social safety-net

NTFPs are often relied on in times of social, economic and climatic hardship or disaster. When a household experiences a shock, they might turn to NTFPs to substitute their consumption or

[1] Note that total forest income includes subsistence use and income from carbon credits and ecotourism.

income. For example, in a recent study Mulungu and Manning (2019) find that households that experience a weather shock increase their collection of NTFPs. Several studies have found NTFPs to be the most important coping strategy in response to shocks (Debela et al. 2012; Kabala et al. 2013; for an overview of studies on shocks and NTFPs in different continents see Wunder et al. 2014). Shackleton and Shackleton (2003) therefore differentiate between this 'emergency net' function of NTFPs and the 'daily net' function, as described in the previous sections.

Households that use NTFPs as a safety-net either substitute goods that they would normally purchase with NTFPs or temporarily sell NTFPs on the market (Shackleton 2004). Wunder et al. (2014) test whether this is the most prevalent shock response using PEN data. They show that other coping strategies, such as asset sales or labor reallocation to other sectors, are more prevalent shock responses compared to (additional) NTFP extraction. McSweeney (2004) notes similar findings, showing that indigenous households in Honduras were more likely to use loans from kin in response to shocks. Strategies based on kinship are also deemed the most important in a study of villages in South Africa, although NTFPs are still used as a complementary coping strategy by 70% of households (Paumgarten 2007). The most recent study on shock response in central Nepal shows that the most important strategies relied on generating cash (loans, selling assets), with only limited role for NTFPs (Moller et al. 2019). Thus, it seems that NTFPs are generally not the main shock coping strategy, yet they do play a complementary role.

Some studies differentiate between shocks that affect all households in a community, such as climatic events (covariate shocks), and shocks that affect a single or small number of households, such as a death (idiosyncratic). Wunder et al. (2014) find that idiosyncratic shocks led to little additional forest use, while covariate shocks were met with decreased consumption and twice as much additional forest use. Deleba et al. (2012) find the opposite when looking at forest users in Uganda. They conclude that idiosyncratic shocks are the primary driver in pushing households toward forest use.

NTFPs can also be used as gap-fillers in case of seasonal shortages. NTFPs might be able to provide nutrition and health in between crop harvests, as well as substitute some cash income by NTFP sales. Wunder et al. (2014) find little evidence for this, whereas temporary employment seems to play a larger role in gap-filling. Schreckenberg (2004) does find evidence for gap-filling when looking at income from sales of shea kernels in bridging the gap at the start of the agricultural season. Other examples include fuelwood collection in Sierra Leone (Arnold 1994) and sale of

Marula beer in South Africa (Shackleton and Shackleton 2004; see Timko et al. 2010 for more examples).

Several studies examine additional characteristics that might affect the response of a household to a shock. Firstly, proximity to forests and lack of access to markets have been found to be associated with using NTFPs as a shock coping strategy (e.g. Fisher et al. 2010; Wunder et al. 2014). Areas closer to the forests and further away from markets tend to be more isolated and have fewer options to cope with shocks. Secondly, some studies have shown that households with less income and fewer assets rely more on NTFPs as a shock response. Income and asset-poor households might rely more on NTFPs as a safety net, as they have fewer buffers. In addition, higher educated households tend to have access to more lucrative options to gain additional income, increasing their buffers and shock coping options. Wunder et al. (2014) find that NTFPs are a preferred coping strategy by asset-poor (social, physical, land) households with low education, however this was not confirmed for income-poor households. Studies by Fisher et al. (2010), who look at rural communities in Malawi, and Volker and Waibel (2010), who look at uplands in Vietnam, have similar findings on education.

2.3 Conservation

During the 1990's NTFPs were increasingly seen as a 'silver bullet' solution which could provide economic incentives for forest conservation, while contributing to rural livelihoods. While the potential contribution of NTFPs to livelihoods has been shown, the role they can play in biodiversity conservation has recently been more contested (Sunderland et al. 2011). The assumption that underlies the potential for NTFPs to contribute to conservation is that the (monetary) value of NTFPs prevents people from coverting forest into other land uses, such as farming (Evans 1993).

Kusters et al. (2006) question the assumption of conservation and development compatibility based on expert interviews regrading 55 cases of NTFP trade from Asia, Africa, and Latin America. They find that in 40% of the cases, NTFPs commercialization had negative impacts on forests. In cases where harvesters do not have control over the land use of current forests, they at least are not able to convert forest to other land uses. In such cases, commercial extraction could have a negative impact on environmental outcomes on the NTFP species and ecosystem level. However, if forest was converted for other land-use, the environmental outcomes are deemed to be even more detrimental (for NTFP species, ecosystem and landscape). Overall, the authors conclude that development outcomes are often at odds with conservation outcomes (Kusters et al. 2006).

To prevent overharvesting, various authors note that sustainable management of NTFPs is essential (Ticktin 2004). According to Sunderland et al. (2011):

> Ecologically, harvesting can only be considered sustainable at the species level if it has no long-term deleterious effect on the reproduction and regeneration of the plant or animal populations being harvested. In addition, harvesting should also not have any discernable adverse effect on other species within the community, or on ecosystem structure or function (212).

While there are many economic, socio-political, and ecological factors influencing whether NTFP harvesting is sustainable (see Ticktin and Shackleton 2011), very few studies have focused on the ecological dimension (Sunderland et al. 2011). Sills et al. (2011) argue that this lack of understanding of the interaction between species' life cycles and harvesting inhibits improved management techniques and technical solutions.

2.4 Relevance

A review of the literature shows that a lot of research has been done with regards to NTFPs. The different roles NTFPs can play in rural livelihoods have been identified, yet the empirical evidence is not always conclusive or might differ for each context. As mentioned in the introduction, there are just a few studies that look at NTFPs in the context of Sierra Leone and the Gola Rainforest. Only the study by Davies and Richards (1991) comes close to empirically examining the consumption and income generation roles played by NTFPs. While they give a first indication of the types of NTFPs collected and the extent thereof, their sample is not representative, and the data were collected over 30 years ago. Furthermore, none of these studies specifically looks at the social safety-net function of NTFPs. Therefore, there seems to be a considerable gap in the literature on NTFPs in the context of Sierra Leone and the Gola Rainforest.

3. Theoretical and conceptual framework

The definition of NTFPs that is adopted here is a modified version of the one proposed by de Beer and McDermott (1989). NTFPs are defined as all biotic materials other than timber which are extracted from forests or nearby grasslands for human use. NTFPs are not cultivated or domesticated in a strict sense, such as cassava grown on a farm, yet some NTFPs might be influenced by human intervention in their respective ecosystem, for example through sustainable harvesting techniques.[2] NTFPs are extracted on a non-industrial scale and can include wood products from trees that are used locally, such as hard wood used as a building material. Fuelwood is also recognized as an NTFP but excluded in the subsequent analysis due to a lack of data.

As pointed out by a large literature, NTFPs have been used as a social safety-net in response to shocks. Consumption and income from NTFPs can act as natural insurance for households experiencing social, economic or climatic hardship (Shackleton and Shackleton 2004). For example, bad weather may lead to crop failure or the death of a breadwinner may lead to a shortfall in income. Households that experienced a shock could therefore be expected to be more likely to engage with NTFPs. Nonetheless, shock types have been found to have varying effects on NTFP engagement. Idiosyncratic shocks, those that affect a single household such as a death or sickness, might reduce labor availability. In turn, the likelihood that households turn to labor-intensive responses such as NTFP collection and sales might be lower. Instead, households might draw on loans, kinship ties, or alternative employment options to cope with such a shock. On the other hand, covariate shocks, such as bad weather, affect all households in a community. In such cases, coping strategies that rely on the community could become less feasible as everyone is negatively affected and cannot provide each other the support (Wunder et al. 2014).

H1: Households that experience a covariate shock are more likely to engage with NTFPs, while there is no effect for households that experience an idiosyncratic shock.

Several studies have found that NTFP engagement is influenced by the geographic constraints forest users face. Due to the rural and remote setting in which most NTFP users live, they have limited access to markets (Shackleton et al. 2011). Long distances and poor road quality and access make transport costly, thus limiting the ability of rural people to participate in the market economy.

---

[2] Leach (1994) observes that people selectively protect, preserve and encourage wild plant species in cultivated and fallow land.

The latter is often compounded by lack of access to finance, poor communication systems and limited information flows (Kar and Jocobson 2012). In turn, this limits the income earning opportunities and market-based coping strategies. All the while, other than the opportunity cost of labor, NTFPs are effectively free to extract from nearby forests and access to them increases as forest is more abundant. Therefore, households living in areas with more forest around and with less markets access are expected to rely more on NTFP collection in response to a shock, while they are expected to rely less on selling NTFPs.

H2: Households that experience a shock and live in areas where forest is more abundant are more likely to collect, and less likely to sell, NTFPs.

H3: Households that experience a shock and live in areas where markets are less accessible are more likely to collect, and less likely to sell, NTFPs.

Poorer households often rely more on NTFPs as coping strategy, as they have fewer buffers (McSweeny 2004). Wealthier households might be able to sell assets or use savings to deal with negative shocks. Similarly, higher educated household heads tend to have access to more income earning opportunities and a wider variety of shock coping options (Völker and Waibel 2010). Households that are poor both in terms of physical and human capital are therefore expected to more likely to engage with NTFPs in response to shocks.

H4: Households that experience a shock and are asset poor are more likely to engage with NTFPs.

4. Context and Study Site

4.1 Background of the study and study site

This study examines rural communities in an area surrounding the Gola Rainforest National Park (GRNP). The park is located in the south east of Sierra Leone, close to the border with Libera. It spans 71,000 ha and consists of three distinct forested blocks, including Gola North, Gola Central and Gola South. Moreover, it lies in seven chiefdoms (Malema, Gaura, Nomo, Tunkia, Koya, Makpele and Barri) across three districts (Kailahun and Kenema in Eastern Province and Pujehun in Southern Province). The GRNP is the largest remnant of the Upper Guinea tropical moist lowland high evergreen forest, which is in the top 25 of most important biodiversity hotspots worldwide (Myers et al. 2000). The park contains a large number of mammals, birds, amphibians and plant species, many of which are endemic to the Upper Guinea forests. A dry season spans from November to April, with average annual rainfall between 2500-3000 mm which mostly all falls between May and October (Jucker et al. 2016).

Due to its biodiversity, the Gola Rainforest has long received attention from the government of Sierra Leone and (inter)national NGO's. Since the late 1980's efforts were undertaken to establish strict nature reserves, but these efforts were interrupted by the civil war between 1991 and 2001 (Forestry Division 2009). After Sierra Leone returned to stability, work was resumed and in 2011 the Gola Rainforest was officially established as a national park. Currently, the GRNP is jointly managed by the Conservation Society of Sierra Leone (CSSL), the Forestry Division of Sierra Leone's Ministry of Agriculture, Forestry and Food Security (MAFFS), the paramount chiefs from the seven chiefdoms and the Royal Society for Protection of Birds (RSPB). These partners have together established a not-for-profit company called Gola Rainforest Conservation LG (GRC), which works to conserve both the GRNP and forested areas around the park. GRC has employed a combination of traditional conservation practices (i.e. rangers patrolling the forest) and development projects in order to encourage the preservation of the Gola Rainforest by local communities.

Most of the people living around the GRNP rely on agriculture, which is characterized by subsistence slash-and-burn rotational cropping of annual crops such as upland rice, cassava, and vegetables. Furthermore, there are some plantations producing cash crops such as cocoa, palm oil and coffee. Inputs such as fertilizer are low, due to the lack of access to markets and high costs of transportation (RSPB 2015). Moreover, some households engage in mining and logging, some of which for commercial purposes. Most households also engage with hunting and collection of NTFPs, of which some are also sold.

As noted, the main conservation strategy for the GRNP is based on restricting the extraction of resources from the park, including logging, hunting, mining and plant harvesting. While communities around the park have been compensated for direct losses due to these restrictions, they are still allowed to sustainably extract NTFPs and fish which contribute to meeting their basic needs (RSPB 2015). Monitoring by means of satellite images shows that the objectives of protecting forest cover inside the GRNP have largely been met. In recent years the focus of authorities' efforts and resources has therefore shifted to forest conservation and sustainable land management beyond the park boundaries (Wilebore et al. 2019). Next to the carbon sequestration function of forest cover, the preservation of mature forest patches outside the national park is especially important for habitat connectivity. Because the GRNP is made up of three blocks, the forest patches outside of the park boundary are believed to act as steppingstones for the migration of animal and plant species across the landscape (Saura et al. 2014). Park authorities have therefore explored several interventions meant to provide incentives to reduce forest clearing for other land-use purposes outside the GRNP. Providing households with an unconditional transfer was found to increase land clearance in the short run (Wilebore et al. 2019). More recently, FEC's living around the park have been the beneficiaries of the Gola REDD livelihood program. This project, meant to reduce emissions from deforestation and forest degradation in developing countries (REDD), is funded by the sale of carbon credits validated by the Verified Carbon Standards and the Climate, Community and Biodiversity Alliance (RSPB 2015). The livelihood program included a number of trainings with regards to agricultural productivity, income diversification, financial independence and stability, sustainable forest management and environmental awareness (ibid).

Because forest conversion for agriculture is the largest driver of deforestation, park authorities have expressed interest in the role that NTFPs can play in conservation. Higher engagement with NTFPs by local communities could provide an incentive to preserve the forest from which they can harvest these products. Moreover, NTFPs might contribute to sustainable livelihoods through their consumption, social safety-net and income generating functions.

4.2 NTFPs in the context of Gola Rainforest

Previous studies of NTFPs in the context of Gola Rainforest broadly categorize them into species used for (i) food, (ii) building and (iii) medicine. Food includes animals that are hunted or trapped, and plants, mushrooms, yams and honey which are gathered. Building materials mainly include board and poles for construction of houses, thatch for roofing, and rope, twine and sticks used for construction (huts, fences, furniture) but also for making equipment (e.g. baskets, scoop nets, mats, hammocks, traps, brooms). Many plants used as building materials or food also have medicinal properties used by traditional healers to treat a variety of ailments. Some plants are gathered specifically for curing certain diseases, such as malaria (Davies and Richards 1991). A second distinction that can be made is between those species that are mainly consumed and those which are sometimes sold. While most NTFPs are consumed, some are sold in the village or local markets and thereby generate a small share of household income.

Firewood is another important NTFP category, often omitted from studies because it is not recognized as a NTFP or because its impact on the environment and local economy is considered small. Leach (1994) notes mainly women collect firewood as they use it for cooking, smoking meat or fish, and processing palm oil. Most of the wood becomes available when upland bush is brushed (cleared and burned) for rice farming, yet dead wood from the forest floor is used throughout the year. Due to a lack of data on firewood, this category will not be focused on further.

4.2.1 Gathered foods

Gathered foods have two main functions in the local diet: first as ingredient in meals, usually put in a sauce to be eaten together with rice, and second as hunger foods. The period towards the end of the rainy season, and before the harvest between late October and December, is known as the hungry season as rice stocks often run low. In turn, people eat hunger foods, such as bush yams, as a replacement staple food. In general, it is the responsibility for women to cook, so they tend to be the ones that collect vegetables used as sauce ingredients. For some foods people make specific trips, for example when certain mushrooms are in season. Others are collected when travelling between villages or when working on farms or plantations. Men are mostly responsible for staple food provision, so they tend to collect hunger foods more often. All people tend to eat certain foods, especially fruit, as snacks (Leach 1994).

Hunting and fishing provide meat used in sauces, food in the hungry season and a source of income. Few livestock are kept, so wild animals provide most of the protein in local diets.

People believe meat or fish should be added to every meal in order to make a proper meal. Hunting is primarily a men's activity, with most animals shot or trapped during the rainy season when men are less occupied with their rice farms. Some hunters use guns to shoot bigger animals for bushmeat, but most animals are caught using traps in order to protect crops (Leach 1994). Traps are usually set in fences around farms to catch smaller animals such as rodents. Bushmeat provides an important food supplement in the hungry season. Fishing, on the other hand, is dominated by women and mostly done during the dry season, when women are less occupied with their farms. Moreover, during the dry season rivers become shallow, so it becomes easier to catch fish. Fishing in dry season and hunting in rainy season are seen as complementary to each other. An exception are non-farm animal traps and fish traps, which are set throughout the year. As people tend to set and check these traps on their way to and from work, seasonal labor demands do not form a restriction (ibid). In the survey conducted by Davies and Richards (1991) mammals only make up 37% of animals hunted or trapped, while fish, reptiles, crustaceans and amphibians make up 60%. They note that most animals are eaten, but some bushmeat and fish is dried and sold in local or Kenema markets. Moreover, they stress that the amount of fish caught is much higher than previously thought and future conservation efforts should focus on preventing fish stocks from depletion.

Wild vegetables are mostly gathered by women and used when cultivated ones are scarce or unavailable, and for variation in people's diet. Where vegetables provide both content and flavor to meals, mushrooms are mostly used as a meat or fish replacement. As stated before, fruits are mostly eaten as snacks and bush yams serve as hunger food. The extent to which the latter are eaten can vary considerably due to circumstances, such as a bad harvest affecting rice supplies. Tasks involving tree-climbing are exclusively men's work, such as collecting honey and palm fruit. Honey is considered a luxury good and occasionally sold, whereas the highly valued palm oil is seen as an essential sauce ingredient to every meal. Other seeds from which oil is extracted are mainly consumed by women who cannot afford to buy the more expensive palm oil (Leach 1994).

4.2.2 Building materials

Collecting and processing building materials is done by men, who gain the knowledge and skills involved as part of their teenage initiation into secret societies or from family members. Initiation into secret societies includes 'schooling' of initiates in their understanding of socio-cultural issues, such as expected behavior of each gender regarding work and marriage relations, as well as certain secret knowledge (Leach 1994). Locally used timber is sawn with two-person pit saw and used for construction of buildings. As noted above, poles and rope are also used for construction. Thatch is used as roofing for some buildings, even though most have zinc roofs. For example, annually each upland farming household builds a farm hut for which thatch is used as roofing. Much of the equipment used in everyday life is made locally, from various parts of wild plants, as it is not available for purchase elsewhere or is too expensive. Several types of leaves are used to wrap food in order to conserve or transport it. Mainly rattan products, such as baskets, are sold and provide a small source of income (Davies and Richards 1991).

4.2.3 Medicine

There are a wide range of plant parts used to prevent and treat medical conditions. While some people might have access to Western medicine from government clinics, drug traders or NGO's, these are often expensive or difficult to obtain. Moreover, even when people use Western drugs, they often use traditional medicine alongside them. The Mende people make a distinction between normal medicinal uses of plants and the activities of traditional healers. Many plants, including some primarily consumed as food, are thought to have medicinal properties or are good for one's general wellbeing. These can be gathered by anyone on a day-to-day basis. Someone with a specific (rare) condition or ailment might turn to a traditional healer. To get treatment, one has to make certain payments to request the healer to collect the medicine and apply it effectively, with larger payments if they want to acquire the knowledge to prepare and apply the medicine themselves (Leach 1994). Some medicinal plants are also sold in local and urban markets, with the latter having especially high volumes of trade in plants used to treat malaria (Jusu and Sanchez 2013).

5. Descriptive analysis

This study uses a mixed-methods approach which is divided into two main parts: (i) descriptive analysis and (ii) correlation analysis. This section describes the methodology used for the descriptive analysis and presents the results. A number of different qualitative and quantitative data sources are used to describe different NTFPs and their role in livelihoods.

5.1 Methodology

5.1.1 Data used

The descriptive analysis mainly draws on (i) a cross-sectional dataset of socio-economic data gathered from villages around the GRNP collected in 2019 (REDD). Additionally, information is taken from (ii) cross sectional data on NTFPs from a different set of villages around the GRNP in 2013 (2013 NTFP), (iii) a survey done on NTFP by Glyn Davies and Paul Richards between 1988 and 1989 (Davies and Richards 1991), (iv) fieldwork undertaken in Sierra Leone in 2019, (v) academic work by Davies and Richards (1991), Leach (1994), and Jusu and Sanchez (2013), and (vi) an online database of tropical plants.

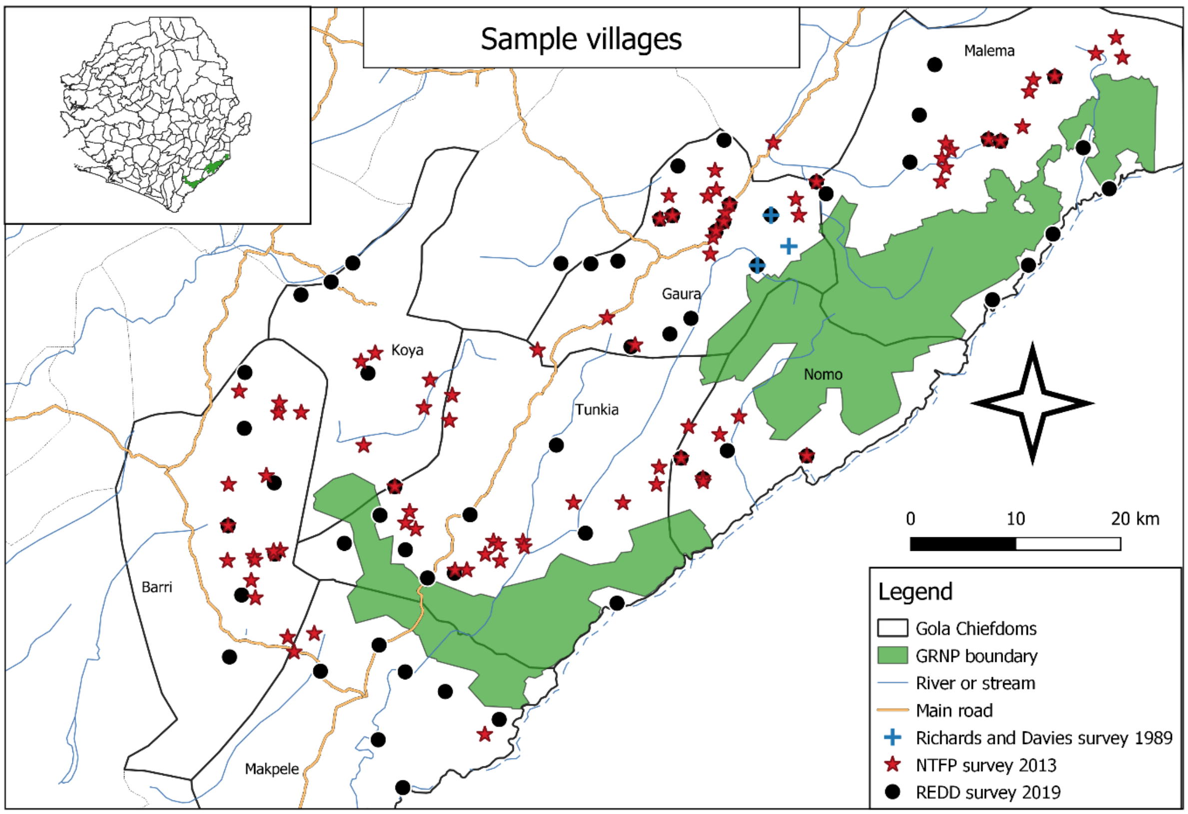
The main data that will be analyzed comes from a cross-sectional dataset containing socio-economic data from 59 villages around the GRNP, collected in 2019.[3] From the 187 villages throughout the 7 chiefdoms of the Gola region that were identified in a 2010 census, 59 villages were randomly selected to be monitored (see figure 1). The data were collected for an impact assessment of the Gola REDD project; hence the dataset will be referred to as REDD data from now on (RSPB 2015). Some data were gathered on village level, but most on household level, including data on NTFPs. In all villages a community meeting was held, and a village survey was conducted with the majority of the village present. Furthermore, 15 household heads per village were randomly sampled to be interviewed. In case a household head was not present, a representative of the household was interviewed. In total 841 households were interviewed in 2019, the data were all gathered in June. Most survey questions pertain to the previous year (2018).

The 2013 NTFP survey contains cross-sectional data on 92 villages around the GRNP. The dataset includes detailed information on specific NTFPs and their attributes, as well as data on a framed field experiment. The latter will not be analyzed in the current study. All data were collected on village level. There is some overlap with villages in the REDD survey, though

[3] The REDD dataset is actually a panel dataset, with a baseline survey conducted in 2014 and the follow-up survey done in 2019. For this research only the 2019 data is used.

coordinates could not be identified for 8 villages. The survey by Davies and Richards (1991) identifies a variety of NTFPs collected by communities from three different sights, including the Mende and scientific name, and where the NTFP was collected. The survey was conducted in 1989.

Figure 1: Sample villages around the GRNP



Source: author.

Qualitative data were gathered during fieldwork in Sierra Leone between November and December 2019. This included field visits to several communities in Malema chiefdom, a visit to the GRNP in Makpele chiefdom, and a focus group discussion with members from several villages in Gaura chiefdom. The focus group discussion asked participants to list the 10 most important NTFPs they collect for (i) food (ii) medicine and (iii) income, with additional questions about these NTFPs followed by a semi-structured discussion about the role of NTFPs in people's lives. During all field visits informal conversations were held with local community members and GRC staff in order to understand more about NTFPs and the context of the Gola Rainforest. The expertise of Mohammed Swaray, the botanist at GRC, helped to identify scientific names of NTFPs and some of their characteristics. Furthermore, several NTFPs were identified and photographed in the forest, communities and markets (see appendix V).

Academic works by Davies and Richards (1991), Leach (1994), and Jusu and Sanchez (2013), provided valuable information with regards to NTFP types, characteristics and their role played in livelihoods. The Useful Tropical Plants Database (2020) provided additional information on NTFP species, used to establish what type of plant a NTFP was and how tall they can grow, for example.

5.1.2 Analysis strategy

NTFPs are operationalized according to the definition set out in Section 3 and classified according to the categories used in the REDD survey. The latter categorized NTFPs into (i) hunted or trapped food (ii) vegetables (iii) fruit (iv) building materials (v) other gathered foods and (vi) medicine.

The categories used in the REDD survey are not always straightforward and mutually exclusive. Firstly, one part of a plant could be categorized as a vegetable while another part as fruit. For example, the seed of *sagbei* has been categorized as a vegetable, but the seed is found inside a sweet edible fruit (personal communication 2019). Secondly, some species produce edible parts that are consumed as foods but are also used as medicine, for example *hewei*, *fawei*, *kikpoi*, and *kpei*. The same counts for some species used as building materials. Thirdly, the names of the categories ‘vegetables’ and ‘fruits’ could be misleading. The former category includes leaves, seeds, and roots which might not typically be recognized as vegetables. Meanwhile, the latter category mostly includes sweet edible fruit, but also includes some seeds and an herb. The REDD data suggests there was also some confusion about this among local communities, as several respondents listed NTFPs from the ‘vegetables’ category when answering questions about the ‘fruits’ category, and vice versa. Moreover, some respondents listed cultivated vegetables or fruits, such as cucumber, maize, guava, mango, instead of those wild species deemed to be NTFPs.[4] Other data sources categorize NTFPs differently and might use different definitions of what species are included. For example, the 2013 NTFP survey does not include hunted or trapped animals. Lastly, the REDD survey only asked about palm oil from planted palms, not from wild palms. GRC staff suggested this might underestimate income earned from NTFPs, as wild palm oil it fetches high prices in markets (personal communication 2019).

---

[4] Though some vegetables and fruits which are conventionally cultivated can also grow as wild plants in the forest, effectively qualifying them as NTFPs, these are examples of where these products were also collected on farms or plantations.

In appendix II, different data sources are brought together, considering some of the caveats described above, to create a comprehensive overview of all NTFPs that are collected by communities around the GRNP. In practice, this means that any NTFPs which are not recorded by the REDD survey are categorized according to their main purpose, meaning foods as hunted or trapped animal, vegetable or fruit, and the rest as medicine or building material. Nuts, leaves and roots are categorized as vegetables and sweet edible fruits as fruit. If a certain species was explicitly mentioned in one of the surveys or during fieldwork as belonging in two categories, for example as building material and medicine, it is included for both. For simplicity, the order of the categories and species as listed in the REDD survey is followed in the results section where possible. The results sections discussing different NTFPs in detail will refer to the Mende names of NTFPs, as English names could not always be identified. For simplicity, the English name of a NTFP or the general category to which it belongs are referred to in the rest of the paper.

The general analysis strategy employed is based on combining descriptive statistics on NTFP engagement with insights from literature and the field. Descriptive statistics are calculated for NTFP collection, consumption and sales. Moreover, mean income from NTFPs, the share of total income earned from NTFPs, and the mean household share of total income earned from NTFPs are calculated to show how the importance of NTFPs for income generation. Furthermore, the share of NTFPs collected from each source and the observed abundance or scarcity are calculated. The same statistics are calculated for each NTFP category, while also showing how often each specific product is collected within each category. Subsequently, the descriptive statistics of the most often collected NTFPs are discussed, bringing in insights from the field and literature.

5.2 Results

This section sets out to give a description of the different categories of NTFPs, the general uses of the most commonly collected products, where they can be found, how scarce people deem them, the gender differences in households who collect NTFPs and how much income they generate. After describing some general results, each NTFP category is considered separately, presenting both qualitative and quantitative findings. Species names and other details can be found in the NTFP overview in appendix II. The main quantitative data comes from the REDD 2019 survey. The latter did not include medicinal NTFPs in the 2019 survey, so these are not discussed in this section.

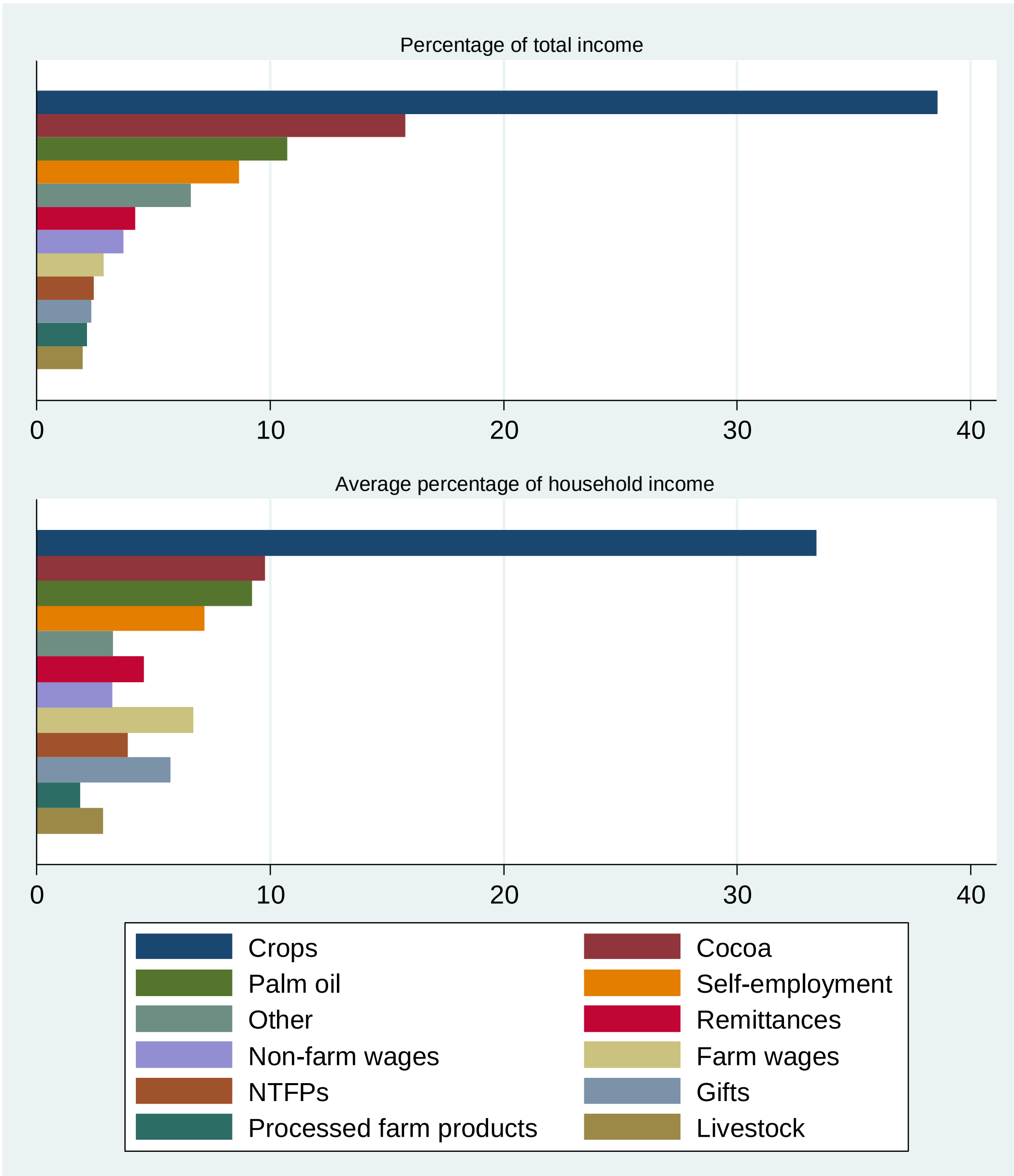
Table 1: Share (%) of households engaged with NTFPs in 2018

	Collected	From collected	
		Consumed	Sold
Hunted or trapped food	37.0	97.1	31.4
Vegetables	29.4	92.7	26.8
Fruits	27.2	92.5	18.9
Building materials	59.5	94.4	0.6
Bush yams	57.1	99.6	9.8
Honey	12.0	95.0	39.6
Mushrooms	15.7	100.0	2.3
NTFPs	85.3	99.2	29.3
N	841	717	717

Source: REDD data 2019.

From the whole sample, 85% of households collected at least one NTFP in 2018. Of these 717 households, almost all consumed at least some of the NTFPs collected, while 29% sold at least one NTFP (see table 1). Thus, where NTFP collection and consumption seem quite common, only around a third of households use NTFPs to supplement their income.

Figure 2: Distribution of income (%)



Source: REDD data 2019.

On average, households selling NTFPs earned Le 164,000 (median 95,000) from these products. Income from NTFPs constitutes 2.4% of total income, comparable to the amount earned from the sale of processed farm products, livestock and gifts (see figure 2 and table 2). Nevertheless, there is variation in the importance of NTFP income for different households. On average, households earned 3.9% of their income from NTFPs, which is a higher share than non-farm wage labor, processed farm products, livestock, gifts and other income sources. Considering only those households that sold NTFPs, the share of total income earned from NTFP sales ranges from less than 1% to 100%, with an average of 16%. The last column of table 2 shows quite some variety in the importance income from each category as a share of total NTFP income for households selling these products. The high share of hunted or trapped food might suggest that certain hunters specialize in bush meat trading for example.

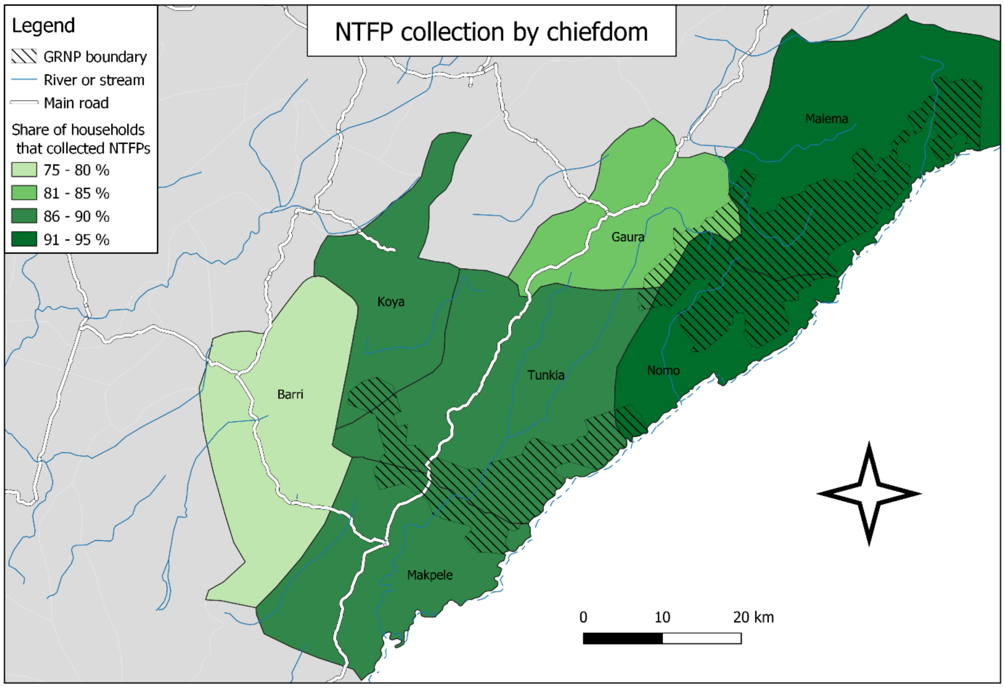
Table 2: NTFP income (1,000 Leones) per household

	N	Mean	SD	Min	Max	Mean percentage (%) of total NTFP income
Hunted or trapped food	93	161.5	193.3	10	1090	82.5
Vegetables	61	160.2	199.6	2	1050	76.5
Fruits	41	94.2	115.6	7	500	70.0
Building materials	3	73.3	46.2	20	100	48.4
Bush yams	44	30.9	22.9	1	150	53.8
Honey	38	68.4	66.1	2	250	61.2
Mushrooms	3	16.7	5.8	10	20	9.2
Total	201	163.8	201.4	1	1220	100.0

Source: REDD data 2019.

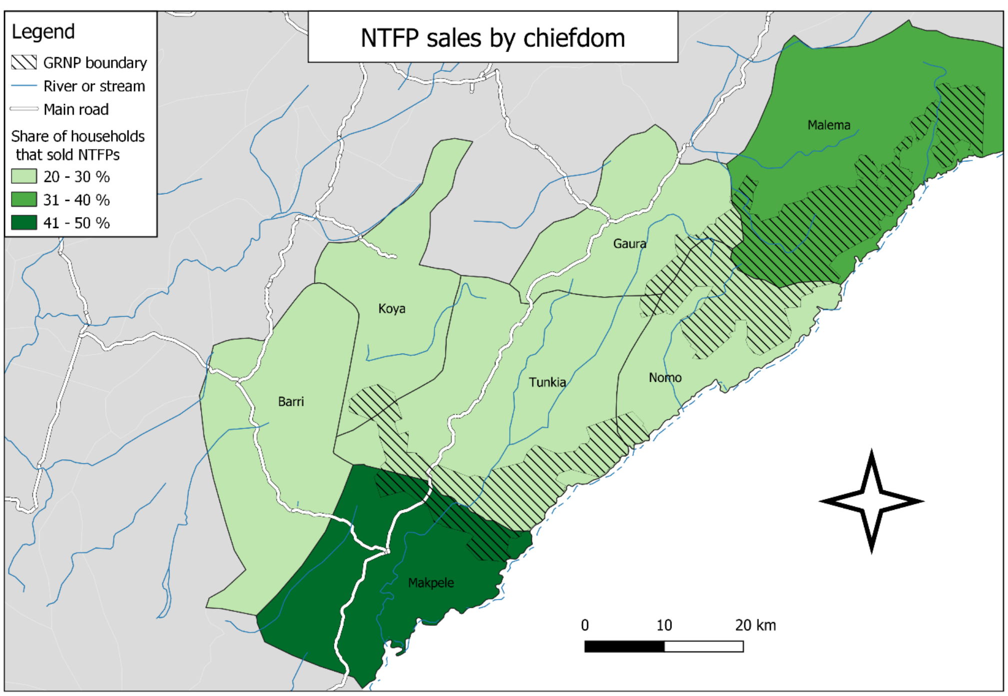
The share of male headed households that collected NTFPs (88%) is higher than the share of female headed households (76%), yet this differs quite strongly per NTFP category. There are also significant regional differences in NTFP engagement (see figure 3 and 4). Nomo chiefdom has the highest share of households collecting NTFPs (94%), followed by Malema (93%). This might be explained by the higher share of forest and bush from the total area of land around villages, which on average is 64% in Malema and 49% in Nomo. Meanwhile, Barri has both the lowest rate of NTFP collection (78%) and sales (23%). This chiefdom also only has an average 15% share of forest and bush and is located relatively far away from the GRNP. Most NTFPs were sold in Makpele chiefdom (50%), whose share is almost twice as high as other chiefdoms. With 32%, Malema has the second highest share of NTFP sales, but it is not much higher than for other chiefdoms. Though Makpele seemingly has little share of forest and bush (7%), this might reflect logging and land clearing for farming, as the forest cover data reflects forest loss (see explanation in section 6.1). Its high share of NTFP sales could be related to demand from nearby urban markets or cross border trade to Libera, but more data is needed to get a better understanding about this.

Figure 3: Share (%) of households that collected NTFPs by chiefdom



Source: REDD data 2019.

Figure 4: Share (%) of households that sold NTFPs by chiefdom



Source: REDD data 2019.

Table 3 shows the source of NTFPs, of which most were collected old bush (27%) and on farms or plantations (23%). The share collected in the forest is only 23%, of which merely over 1% in the GRNP. This goes against the general idea that NTFPs are mainly forest products but fits with the finding by Davies and Richards (1991) that few people venture far into the forest to collect NTFPs. They describe how the Mende living in and around the Gola Forest feel closer to the bush than the high forest, with the latter only becoming socially productive land when it is incorporated into the slash and burn cycle of farming. Moreover, people believe the high forest are inhabited by spirits and involve physical dangers, such as dangerous animals. Therefore, people might only venture into the high forest when a certain NTFP is not available anywhere else (Leach 1994). This could partially explain the very low share of NTFPs collected in the GRNP. Nevertheless, half of the sample consists of villages further away from the GRNP boundary who have to travel further distances to reach the forest, so the share collected in the GRNP could already be expected to be relatively low for this group.

Table 3: Share (%) of NTFPs gathered by source

	Old bush	New bush	Community forest	GRNP	Swamps	Farm/ plantation	Other
Hunted or trapped food	15.1	11.3	14.4	0.5	4.6	53.9	0.2
	(88)	(66)	(84)	(3)	(27)	(315)	(1)
Vegetables	23.2	26.2	22.7	1.0	2.2	24.7	0.0
	(94)	(106)	(92)	(4)	(9)	(100)	(0)
Fruit	29.5	23.0	34.1	1.9	0.0	10.6	0.8
	(109)	(85)	(126)	(7)	(0)	(39)	(3)
Building materials	32.8	3.8	23.4	1.0	36.5	2.6	0.0
	(342)	(40)	(244)	(10)	(381)	(27)	(0)
Bush yams	28.1	15.8	15.6	0.8	0.0	39.6	0.0
	(135)	(76)	(75)	(4)	(0)	(190)	(0)
Honey	38.6	6.9	32.7	4.0	0.0	16.8	1.0
	(39)	(7)	(33)	(4)	(0)	(17)	(1)
Mushrooms	22.0	28.0	20.5	3.8	0.8	25.0	0.0
	(29)	(37)	(27)	(5)	(1)	(33)	(0)
Total	26.9	13.4	21.8	1.2	13.3	23.3	0.2
	(845)	(422)	(685)	(37)	(419)	(731)	(5)

Notes: Frequency in brackets. *Tawei* not included separately as a category, only in the total. Source: REDD data 2019.

The high share of NTFPs collected in bush and on farms or plantations also has a plausible explanation. Firstly, when forest or old bush is cleared for cocoa plantations, productive wild trees are usually kept as shade trees and can be easily harvested for their products. In addition, the timber that can be collected from them is used as insurance in times of hardship, for example when crops fail (personal communication 2019). Secondly, NTFPs are often collected on farms and plantations because it makes agricultural work easy to combine with gathering. Households may be pressed on the amount of labor available and not have enough time for long trips into the forest (Leach 1994).

Households deemed 20% of all the NTFPs they collected (very) scarce and over 60% (very) plentiful (see table 4). This suggests that on the whole, the majority of NTFPs are still widely available to households. Again, there are differences when considering separate categories and products, some of which will be discussed in the next sections.

Table 4: Share (%) of NTFPs considered plentiful or scarce

Species	Very plentiful	Plentiful	Not plentiful or scarce	Scarce	Very Scarce	Total
Hunted or trapped food	26.9	37.0	18.9	14.1	3.1	100.0
	(156)	(215)	(110)	(82)	(18)	(581)
Vegetables	13.6	39.8	22.7	20.7	3.2	100.0
	(55)	(161)	(92)	(84)	(13)	(405)
Fruit	16.3	39.7	19.8	20.9	3.3	100.0
	(60)	(146)	(73)	(77)	(12)	(368)
Building materials	38.0	40.2	12.2	7.2	2.5	100.0
	(396)	(419)	(127)	(75)	(26)	(1043)
Bush yams	9.8	35.6	25.8	26.0	2.7	100.0
	(47)	(171)	(124)	(125)	(13)	(480)
Honey	1.0	16.8	21.8	45.5	14.9	100.0
	(1)	(17)	(22)	(46)	(15)	(101)
Mushrooms	9.8	37.1	18.9	30.3	3.8	100.0
	(13)	(49)	(25)	(40)	(5)	(132)
Total	23.5	37.8	18.3	17.0	3.3	100.0
	(739)	(1187)	(576)	(534)	(103)	(3139)

Notes: Frequency in brackets. *Tawei* not included separately as a category, only in the total. Source: REDD data 2019.

5.1.1 Hunted or trapped food

There are a variety of animals that are hunted or trapped by people in communities around Gola forest (see appendix II). Though few locals regard animals as NTFPs, many are hunted or trapped to collect bushmeat which is directly consumed as food or sold on to earn income. Unlike other NTFPs, it is not allowed to collect animals from the GRNP (except for fish). Overall, 37% of households in the sample hunted or trapped an animal. Most households consumed these, and a substantial number sold at least one animal (31%). Findings by Leach (1994) and Davies et al. (2008) suggest meat and fish are an essential ingredient to any meal, with bushmeat and locally caught fish widely consumed by local households. The average household income from hunting is Le 162,000 (median 80,000), which is roughly equal to that of vegetables, yet higher than all other NTFP categories. In line with work by Davies et al. (2008), these findings indicate that bushmeat trade still plays an important role in local livelihoods, providing a source of protein in local diets and supplying a source of income for some.

Whereas mammals only accounted for a third of all animals hunted or trapped in the survey by Davies and Richards (1991), they make up the overwhelming majority in the REDD survey. Rodents were hunted or trapped most often, accounting for almost three quarters of all animals. They include the giant forest squirrel (Mende: *bofi,* scientific: *protoxerus stranger*), red-legged squirrel (Mende: *bovie*, scientific: *heliosciurus rufobrachium*), cutting grass or cane rat (Mende: *sewulo*, scientific: *thyronomis swinderianus*), other types of rats (Mende: *kulue*, scientific: *cricetomys gambianus*), ground pig (Mende: *kuwui*) and porcupine (Mende: *sejeeh*, scientific: *Atherurus africanus* and *Hystrix cristata)*. Often traps are set in barriers built separating farms/plantations from forest and bush, to protect crops from encroachment by rodents and other animals (see photo 1 in appendix V). This might explain why most rodents were hunted or trapped on farms or plantations (59%). Rodents generated an average income of Le 73,000 per animal sold. Next to every-day consumption and sales, rodents (especially cane rats) are also eaten during the hungry season to supplement diets (Leach 1994). Monkeys (Mende: *kuagaa*) are the second largest category, with over 10% of animals hunted or trapped. They are both eaten and sold in local markets (Davies et al. 2008). Monkeys are also often killed as crop protection measure, especially on cocoa plantations. They get attracted to the sweet fruit found in cocoa pods and are thereby seen to cause crop losses (personal observation 2019).

Table 5: Share (%) of hunted or trapped food

Monkeys	10.4 (61)
Fish	5.8 (34)
Reptiles	1.4 (8)
Rodents	72.4 (423)
Duikers	2.4 (14)
Royal antelope	1.9 (11)
Bush hog/ red river hog	3.9 (23)
Other	1.7 (10)
Total	100.0 (584)

Notes: frequency in brackets. Source: REDD data 2019.

Conversations with community members confirms that hunting is a largely male-dominated activity, whereas fishing is largely done by women (personal observation 2019). They catch fish (Mende: *nyei)* most often during the dry season when streams (partially) dry up and it becomes easy to catch fish using scoop nets in shallow areas. Other ways of fishing include using traps, weighted nets and sometimes rods with hooks (see photo 2 in appendix V). Davies and Richards (1991) report that 20% of animals caught were fish (60% including other animals that live in the water), concluding that, at the time, fishing was a previously underestimated activity. Yet fish make up only 6% of animals hunted or trapped in the current sample. This seems low in comparison with the importance people gave to fish in the focus group discussion in Gaura (it was the only animal listed as an important NTFP) and conversations with local community members in Malema chiefdom. Moreover, the REDD survey was conducted in the dry season, which tends to be when most fish are caught. One explanation for these findings could be bias introduced by the gender of the household head. A male household head might underreport the amount of fish caught by women in his household. As three quarters of households are headed by a male, this could underestimate the amount of fish caught. Similarly, women might underreport animals hunted. Another explanation could be that fish are not deemed as important as other animals, thus not reporting it in the top three of food hunted or trapped in the past year.

Examining the REDD data from 2014 shows that 123 households caught fish in 2013, while only 34 did so in 2019. Thus, there seems to be a definite decrease in fish caught. There could be a variety of reasons for this. Interestingly, the share of households collecting fishing poison (Mende: *tawei*, scientific: *blighia unijugata*) also decreased from 12% to 3% between 2013 and 2018. In the past, fishing poison has been used to stun fish and make them easier to catch. The inside of the nut/fruit called *tawei* is pounded and dispersed in water, which anaesthetizes the fish (see photo 15 in appendix V). During the focus group discussion in Gaura several women noted that they have stopped using this method as they have discovered that *tawei* poisons the water and makes it undrinkable. Moreover, they now know that it also kills fish eggs, which has a detrimental effect on fish stocks (personal observation 2019).

The remainder of animals were hunted or trapped by only a few households. Bush hogs also known as red river hogs (Mende: *ndodeh,* scientific: *potamochoerus porcus*) accounted for 4% of animals, Maxwell duikers (Mende: *kpoka huen,* scientific: *philantomba maxwellii*) and black duikers (Mende: *taowuli,* scientific: *cephalophus niger*) over 2%, royal antelopes (Mende: *hagbe,* scientific: *neotragus pygmaeus*) nearly 2%, and reptiles just over 1%. The category ‘other’ includes four bush cows, one bush goat, two deer, one rabbit and two pangolins.

5.1.2 Vegetables

Vegetables were collected by around a third of households. The category includes leaves, seeds, and roots, which are mostly used in food preparation either to enrich flavor or to thicken sauces. Some seeds (or nuts) are also directly consumed. As explained in the methodology section, local communities do not necessarily recognize these products as vegetables, which are more commonly understood to be cultivated vegetables such as cucumber, eggplant, okra, etc. Most households collecting vegetables consume them (93%), but over a quarter of households also sold at least one vegetable. This generated an average income of Le 160,000 (median 100,000) per household.

Table 6: Share (%) of vegetables

Popondaa (leaf)	41.7 (169)
Gbohui (leaf)	13.1 (53)
Kinjei (gingerroot)	4.2 (17)
Helei (nut)	5.9 (24)
Kimbei (leaf)	8.4 (34)
Sagbei (bitter kola)	12.8 (52)
Mbahei (bush pepper)	11.4 (46)
Kpei (fruit/nut)	0.2 (1)
Gogodi (bush Maggi)	0.5 (2)
Other	1.7 (7)
Total	100.0 (405)

Note: frequency in brackets. Source: REDD data 2019.

Most wild vegetables used in cooking tend to be collected by women, as they are in charge of meal preparation (Leach 1994). For example, the leaf *popondaa* (scientific: *piper umbellatum*), which is collected most often and accounts for over 40% of all vegetables, is mostly used as a sweetener in preparing meals. Similarly, the leaves from *gbohui* (scientific: *triumfetta cordifolia*) and *kimbei* (scientific: *solanum nodiflorum*), which is also known as glossy nightshade, are used in sauces. *Gogodi* (scientific: *solanum verbascifolium*), mentioned by only one household, is also known as ‘bush maggi’ due to its use as a substitute for the well-known stock cube. The seeds of *helei* (scientific: *bussea occidentalis*) and *kpei* (scientific: *beilschmiedia mannii*) tend to be roasted and added as condiments to sauces. *Helei* is eaten for its peanut-like flavor (see photo 3 in appendix V). Lastly, *kinjei* (scientific: *zingiber*) is common gingerroot, used in meals, to make tea and for its medicinal properties.

Sagbei (scientific: *garcinia kola*) and *gbahein* (scientific: *piper* guineense) are commonly referred to as bita-kola (bitter kola) and bush pepper. They are deemed to have the most commercial potential of all vegetables. Bitter kola accounts for around 13% of vegetables collected. It is similar to regular kola nuts but, as the name suggests, is more bitter (see photo 4 in appendix V). Nevertheless, it is often preferred to the regular cultivated version (personal observation 2019). The nut is chewed as a male aphrodisiac, to boost energy (it is rich in caffeine) and is used medicinally against ailments such as body pain, cough, malaria, mild stomachache, worms and to prevent vomiting (Jusu and Sanchez 2013). The nut is found inside a sweet fruit which grows on trees that can grow up to 30 meters tall and is mostly collected on farms or plantations (73%). This suggests that the tree is either left when forest is cleared for cultivation, or the tree might have been planted near inhabited areas and is one of the few (semi) domesticated NTFPs.[5] People usually wait for the fruit to fall from the tree, for example when there has been heavy rain, after which the fruit must be collected quickly before animals get to them. Sometimes the entire kola tree is cut down in order to harvest the nuts. The nuts are then dried and stored inside a plastic bag, where they can be preserved for a relatively long time. Bitter kola traditionally plays a role in ceremonies as well, for example as an offer to the village chief when visiting a community. More recently, GRC has started offering a small amount of money when staff visits a village, but still refers to this as ‘offering the kola nut’ (personal observation 2019).

The commercial value of bitter kola becomes quite clear when considering the data on income and sales. Around 60% of households that collect bitter kola note it is sold. In total, 29 households earned some income selling the nut, amounting to an average income of Le 148,000 (median 100,000). Focus group participants in Gaura noted bitter kola sells for around Le 500-1000 a piece or Le 5,000-10,000 per cup, depending on how far a one has to travel to the market.

[5] The REDD survey did not specify the NTFP *sagbei* but asked whether a household collected kola nuts. Therefore, households might also have reported cultivated kola nuts (*tolo*). Looking at the data, only 7 out of 52 households stated they both cultivated kola nuts and collected them as NTFPs. Therefore, it seems reasonable to assume that most households reported collecting the wild bitter-kola and not the cultivated version.

The closer to a major town, the higher the price tends to be (personal communication 2019). Jusu and Sanchez (2013) note that it is in the top nine of most traded medicinal plants in Kenema, Bo and Freetown markets. Panel data shows that between 2013 and 2018, the share of households collecting bitter kola decreased from 18% to 6%. Meanwhile, the households that regard bitter kola as (very) scarce increased from 7% to 25%. Moreover, the share of those collecting bitter kola that sold it increased from 9% to 56%. This could point to a connection between (increasingly) high prices on markets for bitter kola, unsustainable harvesting and declining abundance as a result. Another possibility, as with other cases, is that as more people try selling bitter kola, they perceive it to be increasingly scarce.

Bush pepper grows on a vine and is similar to ordinary peppercorn. It can be dried to use as spice and seasoning. The stem of the plant also has various medicinal uses, such as treating body pain, colds, fever, headaches and menstruation pain (Jusu and Sanchez 2013). Bush pepper is mainly collected in new bush (30%), community forest (26%), farms or plantations (22%) and old bush (20%). It is deemed the most scarce of all vegetables (35%), which could be due the fact that its often unsustainably harvested. Because the vine usually grows on trees, the plant or even the whole tree is cut down to harvest the fruit. Recently, GRC has taught local forest user groups an improved harvesting technique, which entails sticking a needle (or small sharp stick) in the vine when fruit are ripe. In turn, the fruit falls down without killing the plant (personal communication 2019). While there is no data on the magnitude of (unsustainable) harvesting, it is likely linked to bush pepper's high commercial value. In the focus group discussion in Gaura, as well as the 2018 NTFP survey in Tunkia and Makpele, participants noted the importance of bush pepper for income generation and stressed its high commercial potential. This is also reflected by the fact that almost half of the households collecting the product also sold it. This yielded an average income of Le 167,000 (median 100,000). Jusu and Sanchez (2013) report bush pepper was also in the top 9 most frequently traded medicinal NTFPs in urban markets. Examining the panel data shows that only three households collected bush pepper in 2013, while 38 did so in 2019. Moreover, no household sold any bush pepper in 2013. The increase in collection and sales could be linked to greater awareness about the commercial potential of bush pepper, or because of an increase in prices over the years. Gaura community members noted a cup of bush pepper currently sells for around Le 15,000.

5.1.3 Fruit

The category 'fruit' includes sweet edible fruit, seeds and an herb. While most fruit are eaten as snacks, during work on farms for example, some are also used in preparing meals. The seeds and herb are used for oil and flavoring of food. Overall, 27% of households collected at least one fruit in 2018, with 369 fruit recorded in total. Again, most households collecting fruit consume them, yet almost 20% also sold some. On average, fruit generated income worth Le 94,000 (median 40,000). Fruit therefore seems to have some importance for income generation, yet maybe not as much as hunted and trapped food or vegetables. Most fruit is collected in community forest (34%) and old bush (30%), which seems logical when considering most fruit grow on larger trees found in these areas (personal communication 2019). Yet, the low share collected on farms or plantations could also indicate that wild fruit trees are valued less, thus not left standing or intercropped. According to Leach (1994), fruit are gathered equally often by men, women and children.

Table 7: Share (%) of fruit

Borboi (bush mango)	35.8 (132)
Kikpoi (leaf)	21.7 (80)
Dawei (guinea plum)	12.5 (46)
Fawei (seed)	16.8 (62)
Hewei (guinea pepper)	6.0 (22)
Kondi (sugar plum)	2.2 (8)
Other	5.1 (19)
Total	100.0 (369)

Note: frequency in brackets.

Borboi (scientific: *irvingia gabonensis*) makes up the largest share of fruit collected (36%). It is a sweet edible round fruit with a mango-like texture, also known as bush mango. Its seeds can be roasted and eaten or pressed for oil. The fruit is ripe to eat during the dry season and mostly collected in community forest and old bush (around 40% each), where it grows on trees that can get up to 15-40 meters. It is deemed scarce by over 30% of households, which could reflect its commercial value. A cup can already yield Le 10,000 in Kenema markets (personal communication 2019). Moreover, monkeys tend to also consume the fruit creating competition. Bush mango sales amounted to around Le 48,000 on average (median 45,000) per household.

The three next most collected NTFPs in this category are *kikpoi* (scientific: *crassocephalum crepidioides*) accounting for 22%, *fawei* (scientific: *pentaclethra macrophylla*) for 17% and *dawei* (scientific: *parinari excelsa*) for 13%. *Kikpoi* is a leaf used in sauces, quite similar to others in the 'vegetables' category. It is a small plant that mostly grows in new bush (65% collected there). *Fawei* is a seed that is pressed to produce oil or roasted and eaten (see photo 5 in appendix V). Several seeds grow inside a pod on a tree that can get between 20-40 meters tall. The pods are ready to be harvested or fall down in the dry season. Women who cannot afford to purchase palm oil tend to consume oil made from seeds such as *fawei* (Leach 1994). In addition, the bark of the tree has various medicinal purposes. *Dawei* is a sweet edible fruit also known as a guinea plum (see photo 6 in appendix V). It is often eaten as a snack during work.

Hewei (scientific: *xylopia aethiopica*), also known as Guinea pepper, stands out due to its high commercial value. It is a fruit with peppercorns inside, used to flavor meals in a similar fashion to bush pepper. Besides, the fruit and the plant's leaves have various medicinal uses, such as treating body pain, colds, coughing, fever, headaches, worms, menstruation pain and stomach aches. *Hewei* makes up only 6% of fruit, yet almost half of households that collected it noted they sold some. It was also recorded in the top three of most frequently traded medicinal NTFPs in Kenema, Bo and Freetown markets (Jusu and Sanchez 2013). Yet, the high commercial value has also sparked unsustainable harvesting. When *hewei* is ripe, the pod tends to burst open and the pepper corns fall out (see photo 7 in appendix V). Therefore, the highest demand in urban markets is for unripe fruit. As the tree can get up to 15-30 meters tall, people sometimes cut the entire tree down in order to harvest the green unripe fruit. Recently GRC has provided trainings in improved harvesting techniques, including climbing the tree and cutting down the fruit with a machete (personal communication 2019.

Kondi (scientific: *uapaca guineensis*), a sweet edible fruit, makes up only 2% of fruit collected. The 'other' category includes *kifei* (scientific: *leconodiscus cupanioides*), *bunni* (scientific: *cola lateritia*), *kpei* (scientific: *coelocaryon sp.*), *ndogbo-njaie* (English: bush banana), *mamboi* (scientific: *dialium guineense*), *Ndogbo-lube* (English: bush orange) and *nessie* (English:

bush pineapple). They are all sweet edible fruit and mentioned only collected once or twice. Some are wild occurrences of normally cultivated fruit.

5.1.4 Building materials

Building materials are the most frequently collected NTFPs, gathered by nearly 60% of households. The category includes several species used for construction of buildings, roofing, making rope, and manufacturing of equipment and household items. Most of these materials are consumed (94%), meaning households use the items to construct something for their own use.

Collecting and processing building materials is largely a male-dominated activity (Leach 1994). The knowledge and skills needed for the manufacture of many equipment items are taught as part of men's initiation. Women do not often engage in these activities, as they are afraid of transgressing secret society boundaries.[6]

Table 8: Share (%) of building materials

Kandi (bush stick)	23.5 (245)
Yawi (red hard wood)	3.4 (35)
Baji/ semei (white soft wood)	2.5 (26)
Njasei (thatch)	34.2 (357)
Balue/ Kavui (rattan)	12.9 (135)
Ndovui (bamboo)	11.0 (115)
Yogoi (bush stick)	2.6 (27)
Other Sticks	3.7 (39)
Rope	5.7 (59)
Other	0.6 (6)
Total	100.0 (1044)

Note: frequency in brackets. Source: REDD data 2019.

Opposite to other NTFPs, building materials are most often collected in swamps (37%). Bamboo (Mende: *ndovui*) and rattan (Mende: *balue*, scientific: *eremospatha macrocarpa* and Mende: *kavui*,

[6] Secret societies are highly segregated by gender. Certain knowledge and skills are thought only by men to other men or boys. Members of the other gender tend to fear and/or respect the knowledge and social and political support that are accessed by membership of a secret society (Leach 1994).

scientific: *Laccosperma secundiflorum*) are responsible for this high share, which suggests they tend to grow in swamps most regularly (see photo 8 and 9 in appendix V). The majority of the other building materials is collected in old bush (33%) and community forest (23%). These areas tend to have taller and denser vegetation, which most building materials are harvested from (personal observation 2019).

Overall, building materials were deemed the least scarce (10%) from all NTFPs. They are also the least commercialized, with only three households having sold any building materials. Therefore, there might be relatively low pressure on the population of these species due to overharvesting by local communities. Nevertheless, rattan forms a major exception, with both GRC staff and local communities indicating increasing scarcity (personal communication 2019). In the focus group discussion in Gaura chiefdom, several community members noted that they used to harvest rattan on the edge of the village, yet in recent years they have started to venture further into the forest, sometimes having to walk over 8 kilometers to find any. Rattan's commercial value stems from the variety of household products that can be made from it, including furniture, baskets, fish traps and rice winnowing fanners (see photo 10 in appendix V). Some villagers specialize in construction of products from rattan, collecting the raw material, processing it and transporting the end product to the market. Baskets and chairs are often stacked on top of each other and for long distances to the nearest market. Here traders or members from other villages will come and buy the products, allowing the producers to use their new-earned money to buy needed consumption items (ibid). Traders might sell the rattan products again in urban markets. Some people noted the lack of bargaining power over the price, as they do not want or are unable to carry any leftover items back to their village. Others also sell bundles or raw rattan.

Rattan thus seems to play an important role for income generation. The data only supports this finding to a limited extent. It was collected by 13% of households and is the only building material sold. Yet, merely three people report having sold any rattan. A plausible explanation for the underreporting of income from rattan could be that income from processed NTFPs was not asked for in the REDD survey. Therefore, only those households having sold raw rattan might have reported income. Nonetheless, the amount of raw rattan sold still clashes with the importance it was given in interviews and focus group discussion. In GRC's sustainable harvesting training for forest user groups, rattan even gained special attention as it regenerates slowly, and local communities have started harvesting it more intensively.[7] Meanwhile, a project by the United States Agency for International Development (USAID) has been trying to ramp up production of rattan products in Kenema, sourcing the raw material from local communities around the GRNP. There is also anecdotal evidence that rattan product sales are used as a shock coping mechanism, with a craftsman in Malema chiefdom noting he will produce some rattan products for sale when he knows his children's school fees need to be paid soon (personal communication 2019).

Thatch (Mende: *njasei,* scientific: *raphia hookeri* and Mende: *manie,* scientific: *raffia palm*) was collected most frequently, making up nearly 35% of building materials collected. While many buildings have a zinc roof, various buildings still have thatch roofs. For example, upland farm huts and kitchen/storage barns might have thatched roofs (Davies and Richards 1991; Leach 1994). During fieldwork a school building was in the process of receiving a new thatched roof. Thatch might also be used as a cheaper substitute to zinc, though weaving a thatch roof is labor intensive (see photo 11 in appendix V). Thatch roofs need to be replaced every few years, depending on the quality of the material and intensity of weather (personal communication 2019). Parts of the tree are also used to make a variety of household items and equipment (e.g. hammocks, bags, costumes, traps, mats, fishing nets, see photo 12 in appendix V).

Kandi bush sticks (scientific: *anisophyllea laurina*) are the second most collected building material (24%). The 'sticks' (poles) are used in the construction of buildings and making pestles (see photo 13 in appendix V). *Yogoi* sticks (scientific: *harungana madagascariensis*) and bamboo serve a similar purpose. Camwood or African sandalwood (scientific: *budui*) was not reported in the REDD survey, but is used in a similar fashion, specifically for making axe or hoe handles. *Yawi* (scientific: *heritiera utilis*), which is a red hard wood, and *baji* (scientific: *terminalia ivorensis*) and *semei* (scientific: *chlorophora regia*) which are soft white woods, account for around 3% of building materials each. They are mainly used to saw boards used for construction of doors, shutters, roof beams and furniture (Leach 1994). Soft wood is sometimes preferred as it is easier to cut down and saw, therefore also used to make mortars. Lastly, various species are used to make rope, which is used to attach building poles to rafters, suspend hammocks, construct traps, tie firewood bundles and tie leaves around food (Leach 1994).

[7] An improved harvesting technique which was suggested by GRC staff includes only harvesting mature shoots, but also keeping a number of mature shoots on the plant, which allows it to regrow faster.

5.1.4 Other gathered foods

Bush yams include the species *ngawui* (scientific: *Dioscorea spp.*), which is the main species collected, *bobobutei* and *mei*. They were collected by 57% of households and consumed by nearly all of them. Bush yams are consumed as a food supplement in the hungry season, between May and October (Leach 1994). In this period rice is scarce and bush yams are used as a substitute. In accordance with findings by Davies and Richards (1991), who note that bush yams are mostly found in the protected environment of tree-crop plantations, bush yams are reportedly collected most often on farms or plantations (40%). According to Leach (1994), members of small and female-headed households tend to eat more bush yams as they more often suffer food shortfalls. On the other hand, men tend to be responsible for providing staple foods, so they are also interested in gathering bush yams as hunger foods. She also points out that bush yam consumption varies a lot by year, with emergencies causing increased collection. For example, a hunger due to an influx of Liberian refugees in 1990 was linked to an increase in people eating bush yams. Nearly 30% of households deemed bush yams scarce, which might be explained by increased collection due to an emergency in the past year. Evidence for the social safety-net function of bush yams will be further discussed in Section 6.2. Because of its importance as a hunger food, many villages have bylaws that state that when someone digs up a bush yam, the uprooted vine needs to be replanted so that it will keep producing (personal communication 2019). GRC staff noted that red river hogs cause problems for the bush yam population, as they destroy the whole plant when they eat one. Some households (10%) also sold bush yams, generating an average income of Le 31,000 (median 28,000).

Honey (Mende: *kommi*) was collected by only 12% of households, yet it is a highly commercialized product. While most households collecting honey consume it, 40% also sell some, generating a mean income of Le 68,000 (median 50,000). The focus group discussion and interviews confirm this finding, with most people noting that honey can fetch high prices and is important for income generation. Leach (1994) observes that honey collection is a male-dominated activity, in which men cut down a beehive (or the tree on which it hangs), smoke it out using fire and then collect honey from the combs. This traditional technique kills a lot of the bees, while their home is destroyed. Over 60% of households deem honey scarce, which could point to both the latter unsustainable harvesting technique and the high prices for honey on the market. Recently, GRC has started a pilot that promotes beekeeping, which could provide a sustainable alternative.

Mushrooms (Mende: *falii*) were collected by around 16% of households. All these households consumed mushrooms, with only three selling some. This is less than recorded in a survey by Davies and Richards (1991) who note that edible fungi accounted for 30% of all NTFPs surveyed. The authors note that mushrooms play a much larger role in Mende diets than recognized before. According to Leach (1994) some people stated that they see mushrooms in equivalent to meat, and substitute meat or fish with mushrooms in the rainy season (Leach 1994). Like various other products, mushrooms were collected roughly equally between old and new bush, community forest and farms or plantations. Overall, mushrooms are often collected when come across or when in season (see photo 13 in appendix V).

6. Correlation analysis

The theoretical and conceptual framework set out in Section 3 presented several hypotheses with regards to NTFPs and shocks. This section operationalizes these hypotheses by translating the concepts used to measurable variables. Data availability and the context of the Gola region play an important role in how this is done. Subsequently, an empirical strategy is laid out to test each hypothesis and results are presented.

6.1 Methodology

6.1.1 Data used

The empirical analysis draws mainly on the REDD 2019 data described in the previous section. In addition, forest cover data for the area around the villages included in the REDD data are used. Forest cover data is obtained from Landsat satellite imagery. The dataset on forest loss was created by Hansen et al. (2013) and contains information on the size of the forest around the villages surveyed for the 2010 census (*N = 185*). Based on the pixel colors, an area of land was classified as forest if its covered by trees for at least 50%. Trees are defined as all vegetation taller than 5 meters in height (Hansen et al. 2013). Therefore, older farm bush is also categorized as forest. Weighted Voronoi polygons were employed to determine village boundaries and communities' land holdings, as the latter are often unclear and not formalized in the context of Sierra Leone. The polygons were created with the assumption that the owner of a plot of land is located in the village with the shortest Euclidean distance to that plot. Moreover, the polygons are weighted by population size, which means that larger communities are assumed to hold larger amounts of land. Forest size in a given year is reported in hectares and measured in comparison to the size in 2000 (baseline year), therefore some values are negative.

6.1.2 Dependent variables

The main dependent variables in the empirical analysis are NTFP collection and NTFP sales. Important to note is that the REDD survey did not gather data on how much of a NTFP is collected, thus prohibiting any hypotheses from being tested about the quantity of NTFPs collected or sold. Table 9 shows the operationalization of the dependent variables used. When looking at NTFP sales, only the subset of households that collected a NTFP is considered.

Table 9: Operationalization of dependent variables

Dependent variable	**Subset**	**Operationalized dependent variable**
NTFP collection	Whole sample	Collected at least one NTFP in 2018, if yes = 1
NTFP sales	NTFP collection = 1	Sold at least one NTFP in 2018, if yes = 1

NTFP collection is measured using a binary variable and is equal to one when someone collected at least one NTFP in 2018. In the analysis, the different categories of NTFPs will be aggregated, but also considered separately as there might be large differences between categories. *NTFP sales* is measured using a binary variable and is equal to one when a household sold at least one of the NTFPs they collected.

6.1.3 Independent variables

The main independent variables used are covariate and idiosyncratic shocks. Forest abundance, market access, and assets and education are used to study interaction effects with shocks. Table 10 shows the independent and control variables and their operationalization.

Starting with the shocks, covariate shock is operationalized by creating a binary variable for whether a village indicated to have experienced *low yields* in the past year. The latter is chosen because certain shocks, such as too much or little rain and crop disease, have a more ambiguous effect on households. For example, there might have been excessive rain at the end of the rainy season, yet the harvest could have remained unaffected. *Low yields* create direct stress for most households, as they derive most of their income and sustenance from farming. This shock is also relatively exogenous, as low yields for a whole village are likely to be the consequence of bad weather or crop disease rather than factors relating to a specific household.

Idiosyncratic shocks are measured using a binary variable for whether a household experienced an emergency in the past year for which they did not have enough cash. The shocks included are emergencies relating to a lack of food (*food shock*), health issues (*health shock*) and a death (*death shock*). There might be some more endogeneity issues regarding these shocks, for example a household specializing in NTFP collection might not have such a high income which again influences whether they have access to nutritious food and medicine. In turn, such households might be more likely to suffer from a health shock. The same counts for food shocks, though to a lesser extent for death shocks, as a household member dying is less directly influenced by the household income generating activities. One should therefore be careful in interpreting correlations between NTFP engagement and idiosyncratic shocks.

Table 10: Independent and control variables and their operationalization

	Variable	**Operationalized variable**
Independent	Covariate shock	Low yields, if yes = 1
	Idiosyncratic shock	Food shock, if yes = 1
		Health shock, if yes = 1
		Death shock, if yes = 1
	Forest abundance	Above average forest abundance, if yes =1
	Market access	Above average transport cost, if yes = 1
	Assets/wealth	Above average asset index, if yes =1
		Above average share of adults that received at least some secondary education, if yes = 1
Control	Age household head	Age in years household head
	Household size	Total persons in household
	Dependency ratio	Number of children divided by adults in household
	Gender household head	Female, if yes = 1
	Household head is leader or respected person	If yes = 1
	Household head is a stranger	If yes = 1

NTFP abundance is operationalized by using a binary variable that indicates whether the share of forest land from total village land is above average (*high forest abundance*). In general, binary variables were chosen to study interaction effects because they make it easier to interpret the estimated coefficients. The mean share of forest land is just below 32%, thus villages with a share equal or higher to this have a value of 1 for *high forest abundance*. The share of forest land is calculated by dividing the forest size in 2018 by the total village area. Both areas are measured in hectares and obtained from the forest cover dataset created by Hansen et al. (2013) (see Section 6.1.1).

Market access is operationalized using a binary variable that denotes whether the cost of transporting a 25 kg bag of rice to the nearest market is above average (*high transport cost*). The mean transport cost is Le 14,000. For households facing a high transport cost it will be more expensive to travel to markets to buy and sell goods. Moreover, a high transport cost likely also indicates more travel time, thus these households also face higher opportunity costs for their time. Therefore, transport cost is a good measure for the extent to which households can easily access markets (for income earning opportunities).

Physical capital is operationalized by looking at durable and productive assets, while human capital is measured by looking at education. Both can be considered as measures for household wealth, which is interesting when looking at the way in which poorer and richer households deal with shocks. Durable and productive assets are measured using an index of such assets, which is calculated using a bed as a base value 1, with other assets measured as multiple or a fraction of a bed. For example, a table is defined as 0.5 beds, while a mobile phone as 2 beds (see appendix I for a detailed description). The variable *high assets* is a binary variable that indicates whether a household has more than the average asset index, which is 22.8 (the index ranges from 1.6 to 94.4). The binary variable *high share of adults with secondary education* denotes whether a household has an above average share of adult members that received at least some secondary education. The mean share is 5.7% of household members with some secondary education.

For the control variables, a*ge of household head* is measured in years. *Household size* is measured by adding up the number of adults and number of children in the household. To differentiate the effect of family composition, the number of children per adult is included as the *dependency ratio*. The binary variable *female* denotes whether the household is headed by a woman. *Leader or respected person* is also a binary variable and shows whether the household head has a special position, such as town chief, youth leader, women leader or generally respected person (*gbakoi). Stranger* is another binary variable and shows whether someone is a stranger (*hota*) or citizen (*tali*).

6.1.4 Hypotheses

Table 11 shows the main hypotheses laid out in Section 3, with their respective operationalized hypotheses.

Table 11: Theoretical and operationalized hypotheses

Theoretical hypothesis	**Operationalized hypothesis**
H1: Households that experience a covariate shock are more likely to engage with NTFPs, while there is no effect for households that experience an idiosyncratic shock.	*H1: Households that live in a village where people suffered from low yields are more likely to have collected and sold NTFPs, while there is no effect for households that suffered from an emergency for which they did not have enough cash relating to food, health, or a death.*
H2: Households that experience a shock and live in areas where forest is more abundant are more likely to collect, and less likely to sell, NTFPs.	*H2: Households that experienced a shock and live in a village with an above average share of village land that is covered by forest or bush are more likely to have collected, and less likely to have sold, NTFPs.*
H3: Households that experience a shock and live in areas where markets are less accessible are more likely to collect, and less likely to sell, NTFPs.	*H3: Households that experienced a shock and live in a village with an above average cost to transport goods to the market are more likely to have collected, and less likely to have sold, NTFPs.*
H4: Households that experience a shock and are asset poor, are more likely to engage with NTFPs.	*H4: Households that experienced a shock and have below average assets and household share with secondary education are more likely to have collected and sold NTFPs.*

6.1.5 Analysis strategy

To test hypothesis 1, *NTFP collection* and *NTFP sales* are estimated as a function of covariate and idiosyncratic shocks.

$$Y_{ij} = \beta 0 + \beta 1 ShockC_j + \beta 2 ShockI_i + \varepsilon_{ij} \qquad (1)$$

with

$$Y_i = \begin{cases} 1 \; if \; collected/sold \; NTFP \\ \quad 0 \; otherwise \end{cases}$$

where Y is a binary outcome for household i (i = *1, ... , 799*) in village *j* (*j* = *1, ... , 57*) that collected (or sold) at least one NTFP in 2018, $ShockC_j$ denotes whether a village suffered from low yields in 2018, $ShockI_i$ is a vector of idiosyncratic shocks and ε_{ij} is the independent error term. The fact that first villages were randomly sampled and only then households within these villages were randomly sampled introduces the issue that observations are likely not independent, which is one of the model assumptions of OLS. Therefore, standard errors are clustered by village in all regressions.

A second regression is run using a number of control variables for demography to see whether the result changes when accounting for differences between the makeup of households. Furthermore, chiefdom fixed effects are included to account for (unobserved) differences between chiefdoms (e.g. different regimes that chiefs impose or the proximity to urban areas).

$$Y_{ijk} = \beta 0 + \beta 1 ShockC_j + \beta 2 ShockI_i + \beta 3 X_i + \beta 4 FE_k + \varepsilon_{ij} \qquad (2)$$

with

$$Y_i = \begin{cases} 1 \; if \; collected/sold \; NTFP \\ \quad 0 \; otherwise \end{cases}$$

where everything is the same, except that X_i is a vector of demographic household characteristics and FE_k is a vector of chiefdom-level fixed effects for chiefdom (*k* = *1, ... , 7*).

To test hypothesis 2 the same model is run yet including a variable that captures the abundance of forest and the interaction effects with the different shocks.

$$Y_{ijk} = \beta 0 + \beta 1 ShockC_j + \beta 2 ShockI_i + \beta 3 ForestHigh_j + \beta 4 ShockC_j * ForestHigh_j + \beta 5 ShockI_i * ForestHigh_j + \varepsilon_{ij} \qquad (3)$$

with

$$Y_i = \begin{cases} 1 \; if \; collected/sold \; NTFP \\ 0 \; otherwise \end{cases}$$

where everything is the same, except that $ForestHigh_j$ is a binary variable equal to one when the share of forest from village land is higher than the average. This variable is also interacted with the covariate and idiosyncratic shocks. Again, equation 3 is estimated with and without the household demographic control variables and chiefdom fixed effects.

To test hypothesis 3 a similar model is run yet including a variable that measures market access and the interaction effects with the different shocks.

$$Y_{ijk} = \beta 0 + \beta 1 ShockC_j + \beta 2 ShockI_i + \beta 3 TransportCostHigh_j + \beta 4 ShockC_j * TransportCostHigh_j + \beta 5 ShockI_i * TransportCostHigh_j + \varepsilon_{ij} \quad (4)$$

with

$$Y_i = \begin{cases} 1 \; if \; collected/sold \; NTFP \\ 0 \; otherwise \end{cases}$$

where everything is the same, except that $TransportCostHigh_j$ is a binary variable which is equal to one when the cost of transporting a 25 kg bag of rice to the nearest market is higher than the average. This variable is also interacted with the covariate and idiosyncratic shocks. Again, equation 4 is estimated with and without the household demographic control variables and chiefdom fixed effects.

Lastly, to test hypothesis 4 the same model is run yet including two variables that capture assets and their respective interaction effects with shocks.

$$Y_{ijk} = \beta 0 + \beta 1 ShockC_j + \beta 2 ShockI_i + \beta 3 Income_i + \beta 4 EducHigh_i + \beta 5 AssetsHigh_i + \beta 6 ShockC_j * EducHigh_i + \beta 7 ShockC_j * AssetHigh_i + \beta 6 ShockI_i * EducHigh_i + \beta 7 ShockI_i * AssetHigh_i + \varepsilon_{ij} \quad (5)$$

with

$$Y_i = \begin{cases} 1 \; if \; collected/sold \; NTFP \\ 0 \; otherwise \end{cases}$$

where everything is the same, except that $EducHigh_i$ is a binary variable which is equal to one when the share of adult household members that received at least some secondary school is higher than average, and $AssetHigh_i$ is a binary variable equal to one when the index for durable and productive assets is higher than average. Again, equation 5 is estimated with and without the household demographic control variables and chiefdom fixed effects.

6.2 Testing hypotheses on the social safety-net function

The following sections present the results from the correlation analysis. For each hypothesis tested there is a separate sub-section. First, table 12 provides an overview of summary statistics of the variables included in the models, which are discussed in this section.

As becomes clear from the mean of *low yields*, most households experienced a covariate shock. Around a quarter suffered from a health shock and about a tenth from a food shock. The least occurring shock was one to do with death, with only around 10% of households affected. A bit less than half of households live in an area with higher than average forest abundance, with around a third in areas from which the cost of transport of goods to the market is above average. Lastly, less than half of households have above average durable and productive assets, while only a little over 10% of households have an above average share of adult household members that received at least some secondary education.

Table 12: Summary statistics independent and control variables

Independent variables	N	Mean	SD	Min	Median	Max
Low yields (=1)	841	0.85	0.35	0	1	1
Food shock (=1)	835	0.19	0.39	0	0	1
Death shock (=1)	835	0.09	0.28	0	0	1
Health shock (=1)	835	0.27	0.44	0	0	1
High forest abundance (=1)	818	0.43	0.50	0	0	1
High transport cost (=1)	841	0.29	0.46	0	0	1
High assets (=1)	841	0.43	0.50	0	0	1
High share of adults with secondary education (=1)	841	0.12	0.32	0	0	1
Control variables						
Age household head	840	48.44	15.38	20	45	120
Household size	839	7.06	3.46	1	7	43
Dependency ratio	841	1.30	1.01	0	1	7
Female (=1)	841	0.24	0.43	0	0	1
Stranger (=1)	841	0.17	0.38	0	0	1
Leader or respected person (=1)	841	0.66	0.47	0	1	1

Source: REDD data 2019.

The average age of household heads is nearly 50 years old, though some stated they are over a 100. Because the date of birth is often not recorded, some people have to guess their age which explains the high numbers. Households range from 1 household member to over 40, yet the average size is around 7 people. The ratio of children to adults is slightly higher than 1, though there is some variability in this number. With around a quarter of households headed by women, this number is substantial as it is not usual for women to be a household head (personal communication

2019). A small share of household heads are strangers, while more than half of households heads have a leadership position or are a generally respected person.

6.2.1 Hypothesis 1: NTFP engagement and covariate and idiosyncratic shocks

Table 13 shows the results from the first specification (column 1 and 3) and second specification (column 2 and 4). The first regresses *NTFP collection* and *NTFP sales* on negative covariate (*low yields*) and idiosyncratic (*food*, *death* and *health*) shocks. The second specification includes a number of household demographic control variables and chiefdom fixed effects.

Table 13: Specification 1 and 2 - NTFP engagement and covariate and idiosyncratic shocks

VARIABLES	(1) NTFP collection (=1)	(2) NTFP collection (=1)	(3) NTFP sales (=1)	(4) NTFP sales (=1)
Low yields (=1)	-0.0667**	-0.0607	-0.0474	-0.0823
	(0.0322)	(0.0390)	(0.0644)	(0.0699)
Food shock (=1)	0.0465	0.0363	0.0682	0.0457
	(0.0351)	(0.0346)	(0.0493)	(0.0489)
Death shock (=1)	0.0645	0.0346	0.0286	0.0100
	(0.0484)	(0.0484)	(0.0601)	(0.0623)
Health shock (=1)	0.0300	0.00991	0.0624	0.0297
	(0.0362)	(0.0341)	(0.0467)	(0.0458)
Age household head		-0.00535***		0.000318
		(0.00101)		(0.00144)
Household size		0.000291		-0.00427
		(0.00370)		(0.00599)
Dependency ratio		0.00565		0.0372**
		(0.0143)		(0.0182)
Female (=1)		-0.126***		-0.0632*
		(0.0317)		(0.0376)
Leader or respected person (=1)		0.0242		-0.0681
		(0.0245)		(0.0465)
Stranger (=1)		-0.0268		-0.0401
		(0.0343)		(0.0499)
Constant	0.887***	1.094***	0.302***	0.308**
	(0.0303)	(0.0887)	(0.0605)	(0.116)
N	833	833	710	710
R-squared	0.008	0.100	0.006	0.056
Chiefdom fixed effects	NO	YES	NO	YES

Notes: Robust standard errors in parentheses, clustered by village. Dependent variable in column 1 and 2 is binary, with NTFP collected in 2018 equal to 1 and 0 otherwise. Dependent variable in column 3 and 4 is binary, with NTFP sold in 2018 equal to 1 and 0 otherwise. *Low yields* is a covariate shock, while *food shock*, *health shock* and *death shock* are idiosyncratic shocks. *** p<0.001, ** p<0.05, * p<0.1 Source: REDD data 2019.

Column 1 shows a predicted significant negative correlation between *NTFP collection* and *low yields,* which suggests that households located in a village that suffered from low yields in the past year are predicted to be 7% less likely to collect NTFPs on average. This runs counter to the expectation that covariate shocks would be associated with a higher likelihood of NTFP collection.

One explanation could be that when yields turn out low, extra labor needs to be diverted to other livelihood activities that generate income, such as off-farm labor. In other words, the opportunity cost for engaging with NTFPs in response to a shock might be too high. Controlling for several household characteristics and heterogeneity between chiefdoms increases the standard error of the coefficient in column 2 so it is not significant anymore, however the coefficient itself stays roughly the same. The correlation between low yields and NTFP sales is not significant, but it is negative. A covariate shock was expected to be associated with a coping response that is not based on reliance on other community members, such as selling NTFPs in the regional market. Nevertheless, if all households in a community decide to sell certain NTFPs of the market, this could also drive down prices, rendering the coping strategy less effective. Which mechanism is at play could not be identified with the current data.

There is no significant correlation between idiosyncratic shocks and *NTFP collection*. Neither is there any significant correlation between shocks and *NTFP sales*. In the REDD survey households were asked about the main way in which they dealt with idiosyncratic shocks. Most stated they relied on money from family or a loan (see table 14).

Table 14: Share (%) of households' shock coping strategies

	Source of money to deal with idiosyncratic shock
Family	34.0 (187)
Selling assets	6.9 (38)
Savings and lending scheme membership	10.0 (55)
Loan	40.2 (221)
Other	7.1 (39)
Could not find money	1.8 (10)
Total	100.0 (550)

Note: frequency in brackets. Source: REDD data 2019.

Though reliance on NTFPs was not included as a pre-coded response option, households were able to explain other coping strategies they used. Nevertheless, none of the households explicitly noted they engaged with NTFPs to deal with shocks. An important limitation to note is that households were asked for emergencies for which they did not have enough cash, therefore emergencies that they did manage to deal with are not included (though these might not be defined as shocks).

The same regression as specification 2 was also run for each NTFP category separately. The disaggregated results are presented in table 15. Building materials and mushrooms were not included for *NTFP sales*, as these products were almost never sold. Firstly, the negative correlation between *low yields* and *NTFP collection* only holds for vegetables at 10% significance. A negative correlation is also estimated between *low yields* and fruit sales at 5% significance. Again, households might choose to spend their time on more remunerative activities when yields are low and forego the benefits from collecting vegetables and selling fruit. Or the benefits from selling fruit are low due to excess supply. Another possibility is that low yields go hand in hand with less time spent working on farms, hence less travelling between the village and farms. In turn, this might reduce the opportunities to collect vegetables on the way to and from farms. Similarly, low yields could reduce the number of trips to the market, as fewer crops are available for sale. In turn, this might provide less opportunities to sell fruit. It remains unclear, however, why this should only count for vegetables and fruit, and not for other NTFPs. More data is needed to explore the exact reasons for these findings.

Another interesting finding is the significant positive relationship between bush yam collection and *food shock* and *health shock*. As described in section 5.1.4, bush yams are often used as hunger food. A direct relationship between a lack of food and bush yam collection therefore seems plausible. The correlation with *health shock* might be explained by the fact that a sick household member can do less work or none at all, which adversely affects income generating activities and food supply. In turn, these households might use bush yams when food or cash runs out. The REDD survey also asked a question on households coping strategies when their rice supply ran out, with a few households mentioning they primarily ate bush yams in response. While most households bought rice, this does give a further indication of the use of bush yams as gap filler.

Lastly, comparable correlations are estimated between *health shock* and vegetable and honey collection, and *food shock* and honey collection. These NTFPs might be used in a complementary manner to cope with shocks. For example, some vegetables might be used for their medicinal properties in households that suffer from sickness, while honey could be used to earn some additional income. The significant negative correlation between *food shock* and vegetable sales suggests that households keep these products to consume rather than selling them. The negative correlation between *death shock* and honey sales could indicate that households whose labor supply has been impacted choose not to sell honey on the market, potentially again because they allocate labor elsewhere.

As mentioned in Section 6.1.2, there are potentially endogeneity issues when considering idiosyncratic shocks. The fact that households experience an emergency for which they do not have enough cash means they tend to be poorer households in the first place. Poorer households might be more likely to suffer from sickness, as they cannot afford medicine or a diverse and rich diet that keeps them healthy. Therefore, the correlation that is observed between idiosyncratic shocks and NTFP engagement might actually explain a relationship between vulnerability and engagement with certain NTFPs, a relationship which could run both ways. With the current data it is therefore not possible to draw any definitive conclusions on causality and how these relationships work.

Overall, a mixed picture emerges with regards to the correlations between NTFP engagement and shocks. When considering NTFP collection in general, there no evidence in favor of hypothesis 1. Instead of an increased likelihood of collecting NTFPs, a significant negative correlation is observed for covariate shocks. Furthermore, when considering NTFP categories separately, idiosyncratic shocks seem to be significantly positively correlated to the collection of certain NTFPs, while negatively correlated with NTFP sales. Whether this points to a direct relationship between shocks to individual households and NTFP engagement cannot be determined for most NTFPs with the current data.

Table 15: Specification 2 - NTFP engagement and covariate and idiosyncratic shocks disaggregated by NTFP category

	Collection (=1)							Sales (=1)				
VARIABLES	(1) Hunted or trapped food	(2) Vegetables	(3) Fruit	(4) Building materials	(5) Bush yams	(6) Honey	(7) Mushrooms	(8) Hunted or trapped food	(9) Vegetables	(10) Fruit	(11) Bush yams	(12) Honey
Low yields (=1)	-0.0236	-0.104*	-0.0185	-0.0490	-0.0825	-0.0102	-0.00332	-0.0531	-0.0806	-0.170**	-0.0170	0.0236
	(0.0703)	(0.0550)	(0.0661)	(0.0614)	(0.0897)	(0.0354)	(0.0556)	(0.0802)	(0.0977)	(0.0614)	(0.0449)	(0.107)
Food shock (=1)	0.0103	0.00797	-0.00599	-0.0348	0.129**	0.0617*	-0.0188	0.0465	-0.133*	-0.0651	0.0389	-0.0322
	(0.0337)	(0.0445)	(0.0437)	(0.0434)	(0.0490)	(0.0355)	(0.0368)	(0.0673)	(0.0724)	(0.0668)	(0.0534)	(0.153)
Death shock (=1)	-0.0508	0.0515	-0.0230	0.0429	0.116	0.0499	0.0149	-0.0424	0.0533	0.134	-0.000796	-0.386**
	(0.0760)	(0.0577)	(0.0682)	(0.0693)	(0.0761)	(0.0433)	(0.0506)	(0.0860)	(0.110)	(0.109)	(0.0430)	(0.156)
Health shock (=1)	-0.00448	0.0648*	-0.0262	0.00945	0.129**	0.0708**	0.0308	0.0431	-0.0156	0.000877	-0.000425	-0.151
	(0.0389)	(0.0348)	(0.0355)	(0.0431)	(0.0533)	(0.0298)	(0.0300)	(0.0664)	(0.0728)	(0.0797)	(0.0383)	(0.136)
Age household head	-0.00385**	-0.000249	-0.000632	-0.00406**	-0.00607***	-0.00303***	0.000223	0.00125	0.00123	0.00162	0.00230**	-0.00177
	(0.00150)	(0.00122)	(0.00124)	(0.00133)	(0.00135)	(0.000735)	(0.000844)	(0.00226)	(0.00239)	(0.00215)	(0.00114)	(0.00492)
Household size	-0.00867**	-0.00939*	-0.00273	0.00370	-0.00141	-0.00139	-0.00354	0.00519	-0.00527	-0.00207	0.00287	0.00468
	(0.00381)	(0.00471)	(0.00497)	(0.00471)	(0.00474)	(0.00435)	(0.00276)	(0.00768)	(0.0122)	(0.00472)	(0.00367)	(0.0131)
Dependency ratio	0.00873	0.0412**	0.0435**	0.00513	0.0400**	0.0109	0.0293**	0.0139	0.0351	0.00307	-0.00454	-0.0817
	(0.0161)	(0.0134)	(0.0133)	(0.0151)	(0.0145)	(0.0119)	(0.0116)	(0.0264)	(0.0308)	(0.0299)	(0.0134)	(0.0602)
Female (=1)	-0.371***	0.119**	0.0569*	-0.367***	-0.155***	-0.109***	0.0695*	0.0526	-0.0249	0.156**	0.0184	0.135
	(0.0386)	(0.0359)	(0.0324)	(0.0387)	(0.0392)	(0.0195)	(0.0362)	(0.114)	(0.0610)	(0.0644)	(0.0447)	(0.237)
Leader or respected person (=1)	-0.00856	-0.0429	-0.0565	-0.00823	0.0604	-0.0219	0.0446	-0.0711	-0.0544	-0.0332	-0.113**	-0.213
	(0.0343)	(0.0455)	(0.0357)	(0.0412)	(0.0370)	(0.0273)	(0.0318)	(0.0740)	(0.0883)	(0.0721)	(0.0391)	(0.139)
Stranger (=1)	0.0612	-0.0503	-0.0336	-0.00398	-0.0950**	-0.0110	-0.0237	-0.0108	-0.0470	-0.0574	-0.0124	0.0726
	(0.0384)	(0.0455)	(0.0384)	(0.0560)	(0.0426)	(0.0282)	(0.0407)	(0.0915)	(0.0921)	(0.0797)	(0.0336)	(0.167)
Constant	0.472***	0.383**	0.274**	0.802***	0.686***	0.253***	0.0792	0.235	0.377**	0.103	0.0420	0.897**
	(0.121)	(0.119)	(0.125)	(0.109)	(0.152)	(0.0562)	(0.0814)	(0.279)	(0.171)	(0.152)	(0.0749)	(0.281)
N	829	830	829	831	832	832	831	307	242	223	475	100
R-squared	0.206	0.071	0.068	0.138	0.102	0.068	0.028	0.056	0.119	0.105	0.034	0.152
Chiefdom fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Notes: Robust standard errors in parentheses, clustered by village. Dependent variable in column 1-7 is binary, with a NTFP collected in 2018 equal to 1 and 0 otherwise. Dependent variable in column 8-12 is binary, with NTFP sold in 2018 equal to 1 and 0 otherwise. *Low yields* is a covariate shock, while *food shock*, *health shock* and *death shock* are idiosyncratic shocks. Building materials and mushrooms are excluded as they were rarely sold. *** p<0.001, ** p<0.05, * p<0.1 Source: REDD data 2019.

6.2.2 Hypothesis 2: interaction effect between shocks and forest abundance

Table 17 presents the results from regressing *NTFP collection* and *NTFP sales* on covariate and idiosyncratic shocks and their interaction terms with *high forest abundance*. Column 1 shows a significant positive main effect of *high forest abundance*, which suggests that households in villages with above average forest abundance are more likely to collect NTFPs. Households in such villages are predicted to be nearly 10% more likely to collect NTFPs.[8] This gives credence to the notion that more forest around is associated with more households actually collecting forest products. Nonetheless, the insignificant interaction terms show no evidence for the hypothesis that households who experience a shock and live in villages with high forest abundance are more likely to collect NTFPs.

Column 3 shows there is a weakly significant positive correlation between *death shock* and *NTFP sales,* with households that experienced such a shock estimated to be around 18% more likely to sell NTFPs. However, column 3 and 4 also show a negative correlation for the interaction term between *death shock* and *high forest abundance.* This suggests that households who experienced a shortage of cash to deal with a death and live in areas with more forest around are around 25% less likely to sell NTFPs. It seems that in general a death shock is associated with a higher predicted probability of selling NTFPs, yet in areas with high forest abundance the probability is lower. This gives some limited evidence in favor of hypothesis 2.

[8] Regressing the continuous variable *forest abundance* on *NTFP collection* also yields a significant positive effect.

Table 16: Specification 3 - interaction effect covariate and idiosyncratic shocks and forest abundance

VARIABLES	(1) NTFP collection (=1)	(2) NTFP collection (=1)	(3) NTFP sales (=1)	(4) NTFP sales (=1)
High forest abundance (=1)	0.0972**	-0.0190	-0.0785	-0.210
	(0.0481)	(0.0823)	(0.129)	(0.149)
Low yields (=1)	-0.0517	-0.0760	-0.0963	-0.179*
	(0.0454)	(0.0627)	(0.0947)	(0.0999)
Food shock (=1)	0.0471	0.0379	0.103	0.0706
	(0.0481)	(0.0497)	(0.0654)	(0.0663)
Death shock (=1)	0.0170	-0.0115	0.178*	0.132
	(0.0773)	(0.0834)	(0.102)	(0.110)
Health shock (=1)	0.0294	0.0186	0.0135	-0.0384
	(0.0525)	(0.0471)	(0.0479)	(0.0437)
Low yields*high forest abundance	-0.0580	0.0429	0.0994	0.242
	(0.0568)	(0.0751)	(0.138)	(0.151)
Food shock*high forest abundance	-0.00119	-0.0115	-0.0412	-0.0207
	(0.0723)	(0.0653)	(0.101)	(0.0959)
Death shock*high forest abundance	0.0833	0.0810	-0.268**	-0.243*
	(0.0953)	(0.0946)	(0.122)	(0.124)
Health shock*high forest abundance	0.00862	-0.0216	0.117	0.145
	(0.0724)	(0.0677)	(0.0998)	(0.0948)
Age household head		-0.00538***		0.000624
		(0.00102)		(0.00142)
Household size		-5.62e-05		-0.00196
		(0.00373)		(0.00621)
Dependency ratio		0.00805		0.0292
		(0.0148)		(0.0187)
Female (=1)		-0.127***		-0.0680*
		(0.0328)		(0.0373)
Leader or respected person (=1)		0.0187		-0.0726
		(0.0251)		(0.0452)
Stranger (=1)		-0.0293		-0.0512
		(0.0329)		(0.0505)
Constant	0.852***	1.107***	0.336***	0.356**
	(0.0409)	(0.103)	(0.0900)	(0.127)
Observations	810	810	688	688
R-squared	0.015	0.105	0.022	0.076
Chiefdom fixed effects	NO	YES	NO	YES

Notes: Robust standard errors in parentheses, clustered by village. Dependent variable in column 1 and 2 is binary, with NTFP collected in 2018 equal to 1 and 0 otherwise. Dependent variable in column 3 and 4 is binary, with NTFP sold in 2018 equal to 1 and 0 otherwise. *Low yields* is a covariate shock, while *food shock*, *health shock* and *death shock* are idiosyncratic shocks. *** p<0.001, ** p<0.05, * p<0.1 Source: REDD data 2019.

6.2.3 Hypothesis 3: interaction effect shocks and market access

Table 17 presents the results from regressing *NTFP collection* and *NTFP sales* on covariate and idiosyncratic shocks, and their respective interaction effects with *high transport cost*. Column 1 shows a significant positive correlation between *NTFP collection* and *high transport cost*, indicating that households living in a village where the cost of transporting a 25 kg bag of rice to the nearest market is above average, the predicted likelihood of collecting NTFPs increases by 14%. The correlation between *high transport cost* and *NTFP sales* is not significant, however it is negative. In a regression using the continuous variable for *transport cost*, this variable is negatively and significantly correlated with NTFP sales (see appendix IV). Both results seem to suggest that households that have less market access, measured by the cost of transporting goods to the market, tend to be less likely to sell the NTFPs they collected. Nonetheless, there is no evidence in favor of hypothesis 3, as none of the interaction terms are significant. In other words, the null hypothesis that there is no correlation between engagement with NTFPs and households that experience a shock and have less access to markets could not be rejected.

Table 17: Specification 4 - interaction effect covariate and idiosyncratic shocks and market access

VARIABLES	(1) NTFP collection (=1)	(2) NTFP collection (=1)	(3) NTFP sales (=1)	(4) NTFP sales (=1)
High transport cost (=1)	0.140**	0.00718	-0.104	-0.184
	(0.0415)	(0.0544)	(0.158)	(0.164)
Low yields (=1)	-0.0664*	-0.0676	-0.0602	-0.0900
	(0.0359)	(0.0460)	(0.0681)	(0.0735)
Food shock (=1)	0.0445	0.0378	0.0205	-0.00156
	(0.0455)	(0.0427)	(0.0600)	(0.0558)
Death shock (=1)	0.0831	0.0390	0.0543	0.0158
	(0.0592)	(0.0616)	(0.0735)	(0.0764)
Health shock (=1)	0.0565	0.0373	0.0476	0.0309
	(0.0465)	(0.0459)	(0.0540)	(0.0523)
Low yields*high transport cost	-0.0502	0.0387	0.0731	0.0736
	(0.0477)	(0.0711)	(0.167)	(0.172)
Food shock*high transport cost	0.0157	0.00302	0.162	0.135
	(0.0661)	(0.0567)	(0.105)	(0.102)
Death shock*high transport cost	-0.0618	-0.0125	-0.0872	-0.0476
	(0.0991)	(0.0925)	(0.124)	(0.125)
Health shock*high transport cost	-0.0913	-0.0867	0.0482	-0.0141
	(0.0671)	(0.0696)	(0.105)	(0.104)
Age household head		-0.00526***		0.000250
		(0.000999)		(0.00144)
Household size		0.000117		-0.00541
		(0.00380)		(0.00626)
Dependency ratio		0.00613		0.0380**
		(0.0144)		(0.0181)
Female (=1)		-0.128***		-0.0664*
		(0.0322)		(0.0390)
Leader or respected person (=1)		0.0237		-0.0670
		(0.0246)		(0.0465)
Stranger (=1)		-0.0276		-0.0377
		(0.0344)		(0.0488)
Constant	0.859***	1.086***	0.324***	0.329**
	(0.0332)	(0.0927)	(0.0650)	(0.121)
N	833	833	710	710
R-squared	0.019	0.103	0.012	0.068
Chiefdom fixed effects	NO	YES	NO	YES

Notes: Robust standard errors in parentheses, clustered by village. Dependent variable in column 1 and 2 is binary, with NTFP collected in 2018 equal to 1 and 0 otherwise. Dependent variable in column 3 and 4 is binary, with NTFP sold in 2018 equal to 1 and 0 otherwise. *Low yields* is a covariate shock, while *food shock*, *health shock* and *death shock* are idiosyncratic shocks. Market access is measured using the variable *high transport cost*. *** p<0.001, ** p<0.05, * p<0.1 Source: REDD data 2019.

6.2.4 Hypothesis 4: interaction effect covariate and idiosyncratic shocks and assets

Table 18 shows the results from regressing *NTFP collection* and *NTFP sales* on covariate and idiosyncratic shocks, as well as a variable that indicates whether a household has above average levels of durable and productive assets (*high assets*) and a variable that captures whether they have an above average share of adult household members that received at least some secondary education (*high share of adults with secondary education).* In addition, the interaction terms between the latter two variables and the shocks are included. Column 1 and 2 show a main negative correlation between *low yields* and *NTFP collection*. Counter to specification 2, the correlation stays significant when controlling for household demographics and chiefdom fixed effects. Nevertheless, none of the interaction terms is significantly correlated to *NTFP collection*.

Column 3 and 4 show a significant positive main effect for *high assets* and a negative effect for its interaction term with *low yields*. This implies that a household with above average durable and productive assets is estimated to be between 26% and 27% more likely to sell at least some NTFPs they collect. If such a household receives a shock, however, it is predicted to be around 4% to 5% less likely to sell NTFPs. Wealthier households in terms of assets might sell NTFPs more often yet be less likely to use this as a shock coping strategy. This provides some evidence in favor of hypothesis 4 that households which are asset poor rely more on NTFP engagement in coping with shocks. Wealthier households are thought to have larger buffers and more shock coping options, such as selling some of their assets.

The interaction term between *food shock* and *high share of adults with secondary education* in column 3 and 4 is significant and positive when looking at *NTFP sales*. This suggests that households who experienced a lack of food because they did not have enough cash and had an above average share of adults that received at least some secondary education, are estimated to be 23% more likely to sell their NTFPs. This finding seems to go against hypothesis 4 that households with more education have more income earning opportunities, thus increasing their shock-coping options and making them less reliant on NTFP sales.

Table 18: Specification 5 – interaction effect covariate and idiosyncratic shocks and assets

VARIABLES	(1) NTFP collection (=1)	(2) NTFP collection (=1)	(3) NTFP sales (=1)	(4) NTFP sales (=1)
Low yields (=1)	-0.0967**	-0.0937**	0.101	0.0478
	(0.0431)	(0.0403)	(0.0637)	(0.0640)
Food shock (=1)	0.0584	0.0355	0.0779	0.0428
	(0.0498)	(0.0483)	(0.0685)	(0.0677)
Death shock (=1)	0.0499	0.00934	0.0186	0.00945
	(0.0683)	(0.0642)	(0.0973)	(0.0977)
Health shock (=1)	0.00603	-0.0306	0.0596	0.0165
	(0.0494)	(0.0468)	(0.0818)	(0.0809)
High assets (=1)	-0.0349	-0.0471	0.267***	0.258**
	(0.0719)	(0.0635)	(0.0754)	(0.0897)
High share of adults with secondary education (=1)	0.0527 (0.0366)	0.0187 (0.0339)	0.0771 (0.0629)	0.0642 (0.0637)
Low yields*high assets	0.0805	0.0830	-0.321***	-0.302***
	(0.0697)	(0.0629)	(0.0697)	(0.0795)
Food shock*high assets	-0.0519	-0.0331	-0.143	-0.103
	(0.0625)	(0.0607)	(0.111)	(0.107)
Death shock*high assets	0.0525	0.0882	0.0335	0.0398
	(0.0787)	(0.0782)	(0.149)	(0.138)
Health shock*high assets	0.0215	0.0617	0.0630	0.0900
	(0.0622)	(0.0644)	(0.104)	(0.100)
Low yields*high share of adults with secondary education	-0.0389 (0.0510)	-0.0350 (0.0462)	-0.0629 (0.0639)	-0.0184 (0.0651)
Food shock*high share of adults with secondary education	0.0604 (0.0763)	0.0670 (0.0733)	0.224* (0.117)	0.231** (0.114)
Death shock*high share of adults with secondary education	-0.0170 (0.110)	-0.0393 (0.107)	-0.00270 (0.137)	-0.0470 (0.141)
Health shock*high share of adults with secondary education	0.0551 (0.0680)	0.0548 (0.0624)	-0.0653 (0.0889)	-0.0674 (0.0915)
Age household head		-0.00554***		1.16e-05
		(0.00102)		(0.00148)
Household size		-0.00136		-0.00418
		(0.00335)		(0.00658)
Dependency ratio		0.00660		0.0365**
		(0.0145)		(0.0178)
Female (=1)		-0.119***		-0.0504
		(0.0307)		(0.0373)
Leader or respected person (=1)		0.0260		-0.0612
		(0.0231)		(0.0477)
Stranger (=1)		-0.0245		-0.0478
		(0.0354)		(0.0509)
Constant	0.899***	1.126***	0.181**	0.195*
	(0.0437)	(0.0891)	(0.0603)	(0.103)
N	833	833	710	710
R-squared	0.017	0.111	0.038	0.083
Chiefdom fixed effects	NO	YES	NO	YES

Notes: Robust standard errors in parentheses, clustered by village. Dependent variable in column 1 and 2 is binary, with NTFP collected in 2018 equal to 1 and 0 otherwise. Dependent variable in column 3 and 4 is binary, with NTFP sold in 2018 equal to 1 and 0 otherwise. *Low yields* is a covariate shock, while *food shock*, *health shock* and *death shock* are idiosyncratic shocks. *** p<0.001, ** p<0.05, * p<0.1 Source: REDD data 2019.

7. Discussion and limitations

The first sub-section discusses the findings of this study and puts them into the context of the Gola Rainforest and wider literature on NTFPs. The subsequent sub-sections discuss the limitations to the study, and the implications for future research and policy. In doing so, the weight will be on local future research and policy implications, rather than on wider theoretical debates or NTFP policies in general.

7.1 Interpretation of the findings

The way this study defined NTFPs aimed to include a large variety of products. While hard wood used for construction might technically be deemed a timber product according to the definition by de Beer and McDermott (1989), the fact that it is only used locally on a small scale still qualifies it as a NTFP. Some NTFP species might also have been influenced by human intervention, for example rattan which is harvested in a way so that it regenerates faster. Leach (1994) suggests that women have tried to cultivate some vegetables and medicinal plants, which would normally be collected in the wild, in small gardens behind kitchens or houses. Yet the REDD survey does not contain NTFP collection around villages as an option when asking about the source, so little can be said about this. Overall, the high share of some NTFPs (hunted or trapped food, vegetables, bush yams) collected from farms or plantations might not be so much an indication of cultivation, rather indicate that these products wildly occur in these places or are collected there out of convenience.

While the name non-timber 'forest' product suggests the majority of NTFPs are collected from primary forest, the data shows that the majority comes from other areas, such as bush and farms or plantations. Therefore, even if the assumption holds that the NTFPs are highly valued, it might not necessarily follow that this prevents clearing of forest for other land uses. Another conservation issue is that of NTFP species populations themselves. Overharvesting of NTFPs could have detrimental long-term effects on reproduction and regeneration of some species, thereby also threatening livelihoods that depend on them. This study has pointed out some anecdotal evidence of unsustainable harvesting techniques (bitter-kola, bush pepper, rattan, honey) and overharvesting (rattan) of commercialized products, though scarcity of these products is not (yet) reflected in the survey data. Only honey was deemed scarce by more than half of the households collecting it. The implications for both forest and biodiversity conservation, as well as the potential impact on local livelihoods, will be discussed in Section 7.4.

To understand the importance of NTFPs to local communities, this study has explored the roles played by NTFPs in their livelihoods. Nearly all households directly consumed the NTFPs they collected, yet previous literature and fieldwork that was undertaken suggests that few NTFPs seem to play a crucial role in subsistence food provision. Bush yams are the only real staple NTFP that acts as a rice substitute, though it might mostly be consumed as a hunger food rather than as an every-day food. Other products, such as bushmeat, fish, mushrooms, leaves and nuts are mostly used as supplements in meals, though bushmeat seems to be important for food provision in the hungry season as well.[9] Furthermore, this does not take away that these products might be highly important for diet diversity and allow households to spend cash on other goods by substituting consumption goods with NTFPs. Furthermore, building materials play an important role as input for the construction of buildings and manufacturing of equipment. From all NTFPs, they were collected by the highest share of households. Building materials from markets require cash spending and are difficult to transport, which likely affects household's decisions to use NTFPs as a substitute. As will be discussed in Section 7.3, only by measuring the quantity of NTFPs consumed might one be able to quantify the importance of NTFPs to people's sustenance.

Income from NTFPs also seems to be quite important, yet certainly not for all households collecting NTFPs. Only a quarter of all households in the sample sold at least one NTFP. Moreover, there are large differences in how much of total income was earned from NTFPs. The fact that from the households selling NTFPs, almost half earned over 10% and a tenth more than 40% of their income from NTFPs, could point to some degree of specialization in NTFP sales. Yet, it also shows the limited other income earning opportunities for these households.

The results show mixed evidence with regards to NTFPs' social safety-net function. Counter to what was expected, experiencing a covariate shock was correlated with a lower likelihood of collecting NTFPs. Households living in a village suffering from low yields might unable to get help from other village members, yet the results suggest households do not divert labor to NTFP collection. Instead, they may turn to more remunerative activities than NTFP collection, though this could not be assessed with the current data. When examining households' coping strategies in response to idiosyncratic shocks, the data show that households mostly took a formal loan, borrowed money from family or friends, or sold assets. This finding corresponds with

[9] The potential role of bushmeat as a hunger food was not reflected, however, in the results from the correlation analysis.

several other studies that show NTFPs having a limited or no role as the main shock coping mechanism (McSweeney 2004; Paumgarten 2007; Wunder et al. 2014; Moller et al. 2019). Nonetheless, the results do show a correlation between idiosyncratic shocks and increased collection and decreased sales of certain NTFPs. For example, the positive correlation between food and health shocks and bush yam collection gives some evidence for the role of bush yams as hunger food. The strong negative correlation between honey sales and households affected by a death might indicate that the temporary labor deficit refrains a household from marketing honey. As mentioned before, endogeneity might be an issue interpreting these correlations (also see Section 7.2).

A number of interaction effects were also examined, starting with those households that experienced shocks and live in communities with a lot of forest around. As might be expected, areas with a higher share of forest tend to be associated with a higher likelihood of households collecting NTFPs. As over 60% of NTFPs are gathered from forest or bush, it is reasonable to assume that areas with more vegetation also contain more NTFPs. Nonetheless, these areas tend to lie closer to the GRNP and further away from more densely populated areas. This makes it difficult to distinguish whether NTFPs are collected because they are simply abundant or whether people lack alternatives (as suggested by Shackleton et al. 2011b; Kar and Jocobson 2012; Dash et al. 2016 for example). Yet, counter to the expectation, no interaction effect between forest abundance and shocks is observed (as found by Wunder et al. 2014 for example). Households who experience a death shock and live in areas with a lot of forest do seem to be less likely to sell NTFPs. More forested areas tend to be less accessible and further away from markets, making NTFP sales more costly. This is also illustrated by the negative correlation between high transport cost and NTFP sales. NTFP A death in the household could restrict labor supply or further increase the opportunity cost of traveling to the market to sell NTFPs.

Several studies have found poorer households to be most reliant on NTFPs, as they are thought to have fewest livelihood options (Angelsen et al. 2014; Kamanga et al. 2008). Instead of looking at income, which tends to vary from year to year[10], assets and education level might say something about household wealth. Nonetheless, the data show no correlation between asset and education levels and NTFP collection. Households who are relatively wealthy in terms of assets

[10] Household income is considered as highly volatile. Some people may have substantial agricultural revenues one year but see their yields destroyed the next year by crop disease or rodents (Leach 1994).

are predicted to be more likely to sell NTFPs, which fits in with the finding in other studies that wealthier households tend to gain more cash income from NTFPs (e.g. Paumgarten and Shackleton 2009; Zellner 2007; Shackleton 2011b). The results also suggest that asset-richer households who receive a covariate shock are somewhat less likely to sell NTFPs. Wealthier households might have more coping options, thus choosing to forego engagement with NTFPs (Wunder et al. 2014). This is not reflected in the interaction effect between food shocks and high share of adult household members with a higher education level, which is associated with a higher predicted likelihood of collecting NTFPs.

7.2 Limitations

One of the main limitations is that no causal claims can be made on the basis of this study. This has implications for the internal validity of the correlation analysis. One of the main threats to internal validity are (unobserved) confounding variables which might affect the relationship between NTFP engagement and shocks. For example, poverty and vulnerability of households could affect both whether they have enough cash to deal with an idiosyncratic shock and whether they engage with NTFPs. In addition, there might be reverse causality, for example households specializing in NTFP collection and sales causing them to not have enough cash when they are faced with a shock if NTFP do not bring in enough food or cash. While this research does not make any causal claims and is limited to estimating correlations, the latter were tested quite rigorously, applying a variety of different specifications to see whether results stayed robust. Furthermore, the surveys used as the main research instrument were elaborately tested and standardized so to ensure reliability. To ensure the replicability of the results, the variable composition and empirical strategy is stored in a STATA do-file.

The large random sample that was chosen from the study sample ensured relatively high external validity for other villages around the GRNP and boosted statistical power. Occasionally variables were missing for certain villages or households, yet this did not present major problems. The most important was *forest abundance*, which was missing for two villages. A number of observations could have been deemed outliers due to their unrealistic values, yet these were limited to the control variables (e.g. a very old age). Moreover, because of the randomized sample, extreme values are estimated to be equally likely to occur in all villages. Therefore, large variation in some variables is not estimated to structurally bias the results, although it might inhibit the ability to detect statistically significant correlations. Whether the results can be generalized to communities in other forested areas around the world depends a lot on contextual factors. Some of the results supported findings from studies in other contexts, with potentially similar mechanisms in place. Nonetheless, because of the limited understanding of the causal mechanisms at play in the case of communities in and around the Gola Forest, one should be careful to generalize the results to other contexts.

Improved measures for certain concepts and simply more data would have improved this research as well. With regards to the main dependent variables, a large share of the concept NTFP engagement could not be included as no data was available on the volume of NTFPs collected, consumed or sold. With the current data, it was impossible to distinguish a household that collected 20 bundles of rattan, for example, from another household that collected only one bundle. Furthermore, only the top three NTFPs per category were recorded by importance. Therefore, it was not possible to truly measure all the NTFPs households engaged with and the survey likely did not pick up on less widely used NTFPs. The data from the 2013 NTFP survey confirm this, as they include a much wider variety of NTFPs. Especially remarkable is the number of medicinal products mentioned in this survey (and during the focus group discussion in Gaura). The REDD survey did not include an elaborate category of medicinal products, only asking about *tawei* in both years. Another potentially large missing product is wild palm oil. According to GRC staff this product brings in quite a lot of money, yet the REDD survey only asked about cultivated palm oil (personal communication 2019). Hence, the current estimate of NTFP income might be much lower than if this product was also included. Firewood is also not included as NTFP type, though it is the main source of fuel for cooking and is sold quite often on the roadside in villages closer to markets (personal observation 2019).[11]

Another major issue is that only household heads were interviewed, which might bias the answers given. Household heads might not be able to accurately recall NTFPs collected and sold by other household members and rank these NTFPs different in order of importance. The latter issue is quite evident when considering the different NTFPs listed by men and women in the 2013 NTFP survey. Furthermore, the way gender relations are structured in Mende society actively encourages husbands and wives to keep information about their income mostly hidden from one another (Leach 1994, 195). In turn, this is likely to obscure the extent to which mostly male

[11] For a discussion on the increased commercialization and importance of firewood (revenue) to rural communities in Sierra Leone, see Munro et al. (2017)

household heads can make statements about the NTFPs gathered, and the amount of money earned from these, by their wives. No data was available about consumption or sales of NTFPs which were not collected by households themselves. It might be the case that some households buy a lot of NTFPs from other villagers or in local markets. Again, this limits the ability to get a comprehensive understanding of the role NTFPs play in people's lives. In addition, it is not always clear how local communities understand what a NTFP is and whether enumerators presented them with a definition when asking questions about products taken from the forest. Together with the fact that the REDD survey did not include a possible answer option of collecting NTFPs around the village, this makes it difficult to establish if certain NTFPs might also be cultivated.

Another problem is that questions about scarcity are likely to reflect only people's observed scarcity yet might not reflect real scarcity or abundance. If a NTFP increases in value there might be more demand for it, which could emphasize the fact that only a limited amount of these products is available. A high observed scarcity then does not necessarily reflect a decrease in population of this species but reflects only an increase demand. Lastly, directly asking households whether they used NTFPs to cope with shocks could have given clearer answers regarding their social safety-net function (as done by Wunder et al. 2014 for example). Currently, only correlations between shocks and engagement could be estimated, yet it is hard to say whether the higher likelihood of NTFP engagement is causally related to these shocks.

7.3 Implications for future research

There are many fruitful avenues for future research on NTFPs in the context of Gola Rainforest. For starters, obtaining data about quantities of NTFPs collected, consumed and sold would go a long way to getting a more accurate picture of the importance of NTFPs in local livelihoods. Currently it is hard to say more than that most households collect, consume and sell multiple NTFPs, yet the extent remains unclear. For example, future research questions might include how much of food consumption needs are met by NTFPs? Measuring quantities can be quite challenging, as experience with measuring the quantities of agricultural crops for the REDD survey has proven (personal communication 2019). Yet, the decade of doing research around the Gola Forest in cooperation with GRC has provided in-depth knowledge about the different types of NTFPs that are gathered and in what types of quantities they are collected. This should allow researchers to come up with standardized quantity measures. Though 13 different measures were coded in the REDD survey for agricultural produce, it was still difficult to combine these into one measure of quantity. To facilitate this, researchers might have to reduce the number of quantities used and adapt them to the specific type of NTFP. Using a pre-determined measure for quantity can enable researchers to then determine the monetary value of NTFPs collected, either using the market value of NTFPs (e.g. Angelsen et al. 2014) or the value of their substitutes (Kamanga et al. 2008). In turn, the total value of NTFPs collected could be calculated. Market prices could be determined by asking respondents what the value would be if they sold the NTFPs collected, yet some might never sell certain NTFPs so would find it difficult to answer this. Another possibility is measuring the price for each NTFP in the nearest urban market. Bringing physical objects that represent the possible quantities which are measured, such as a standard size basket or cup, can reduce the measurement error introduced by respondents having to guess the size of certain quantities. Next to the amount of NTFPs, collecting data on diet diversity could also increase the understanding of the potential importance of NTFPs in providing different nutrients in local diets.

Future research should also take NTFP engagement by the whole household into account. Only asking the household head is likely to lead to biased survey results, as men and women often do not know the extent of each other's activities and income. There seem to be large differences in the types of NTFPs collected by each gender. More qualitative research could shed a light on how the dynamics around NTFP collection and sales work within the household. This might be vital information in designing effective NTFP policies and interventions that aim to improve the wellbeing of local communities, especially those of women and children.

Other questions remain with regards to the source, sales and scarcity of NTFPs. Firstly, the current data did not allow differentiation between wild NTFPs collected on farms or plantations, and possibly cultivated NTFPs in these places. Moreover, the survey did not include the answer option of having collected NTFPs around the village, which is also a place where NTFPs are collected and possibly cultivated (Leach 1994). Secondly, questions remain about where and to whom NTFPs are sold. While there is some understanding of the possible channels through which NTFPs are sold, such as local markets and traders who resell in urban markets, little is known about the extent to which this happens. Some villages might sell more locally, while others mainly in markets in larger towns. The most recent studies include a market survey of medicinal NTFPs by Jusu and Sanchez (2013) and discussion of bushmeat trade with data stemming from the 1980's and 1990's (Davies et al. 2007), which only gives a limited picture of NTFP trade. Lastly, and most importantly, there is scope to get an even better understanding of where NTFPs are collected and how many are available. Future research by ecologists and biologists could focus on identifying what the population of NTFP species looks like. What is the abundance of NTFPs and in what geographical area are they located? Currently, the only measure available is observed abundance or scarcity. Knowing more about populations that are under pressure will allow policymakers and organizations such as GRC to more effectively target interventions aimed at sustainable management and harvesting of NTFPs.[12] Moreover, it will also inform them on whether NTFP populations can support increased harvesting and commercialization. Currently, GRC has started supporting local communities to form forest user groups (FUGs). There is considerable scope for researchers to evaluate the workings of these in achieving sustainable NTFP management.

From development organizations working in the Gola context, there has been a lot of interest in commercialization of NTFPs. Though this research did not focus on this aspect, it deserves the focus of future researchers. Two main questions should be addressed. First, are there products for which there might be (increasing) demand on regional and international markets? Second, but more importantly, could NTFP populations withstand higher harvesting rates? Already some anecdotal evidence points to overharvesting of certain NTFPs like rattan. Before any initiatives are undertaken that will increase NTFP extraction, the question should be asked whether it is feasible and not detrimental to NTFP stocks and local use. Another interesting question that emerges is whether certain commercially valuable NTFPs could be cultivated. If so, this could open up opportunities for external organizations to support increased production and commercialization.

In a more general sense, the evidence presented in this study provides another data point in wider academic debates about the role of NTFPs in local livelihoods. While NTFPs seem to be important for consumption and income generation, future qualitative research might be able to shed more light on the social safety-net role and uncover ways in which NTFPs are used in times of crisis that could not be established with the current data. In addition, obtaining data on NTFP collection at different times during the year could give more information in seasonal variation and

[12] A special mention of fish is appropriate here, as very few households mentioned hunting or trapping fish in 2019, while the study by Davies and Richards (1991) suggests fishing was widespread. Meanwhile, the authors noted 30 years back that fish stocks should get special attention, as the extent of fishing has been underestimated and fish stocks might be in danger of depletion.

their function as gap-fillers before the harvest. Furthermore, an experimental research design could try to find any causal connection between NTFP engagement and poverty alleviation, which is the focus of more recent literature on NTFPs (see Babulo et al. 2009; Walelign 2013; Rahut et al. 2016; Walelign et al. 2019). This research also taps into a more controversial debate on the notion that NTFPs can be used as a conservation tool. While the findings of this study have shown that the majority of NTFPs are not found in the forest, a significant portion is collected in community forest. Future studies could explore whether NTFPs can actually be leveraged as a reason not to covert community forest into farm land or for other land uses. Contingent valuation might be one way to go about this, yet (field) experimental methods might produce more valid results. Any study that attempts to put value on community forest should, however, consider the non-monetary (e.g. cultural) value of community forests and the institutions that shape practices with regards to these areas.

7.4 Policy implications and recommendations

The findings of this study have implications for conservation and social policies. The main audience for this section is GRC and related local organizations working with communities around the Gola Rainforest, yet the findings can also inform government policy and private sector enterprises.

First of all, the fact that most NTFPs are not gathered in primary forest and revenues from farms and plantations are generally higher than those from NTFPs, reorients the way in which NTFPs can be thought of as a conservation tool. The presence of NTFPs in community forest might not necessarily provide an incentive to conserve the forest. If a cost-benefit calculation is made on land use, the potential returns in terms of consumption and cash crops might outweigh the benefits from NTFP collection. Important to note is that such a calculation will likely include many more factors, such as the cultural significance of community forest and the value of certain ecosystem services that are provided by forests. People might not always be able to rationally weigh the pro's and con's, due to information asymmetries for example. Stressing the importance of community forest as a potential source of NTFPs, as well as making local communities aware of the variety of uses for these products, could influence decision-making on land use in favor of maintaining the community forest or even letting old bush regrow. In doing so, however, it is vital not to overestimate the potential benefits of NTFPs. Providing inaccurate information could alter land use decisions which adversely affect food security of already vulnerable local communities.

Anecdotal evidence does suggest that households find it easy to combine NTFP collection with other agricultural activities, so issues around the opportunity cost of labor might be less of an issue.

GRC has made some inroads by giving training to local communities, providing knowledge about NTFPs, sustainable harvesting techniques and helping locals establish FUGs. They are also planning to establish land use co-management zones, in which GRC and FUGs communally manage (forest) landscapes and harvesting of NTFPs. How these zones will be established and governed is yet to be worked out and beyond the scope of this research. It seems that FUGs could function as central players in governing sustainable NTFP harvesting. What will be important is to get a good understanding of where exactly NTFPs are located and collected, and who is collecting them. A system could be developed in which certain zones are available for NTFP harvesting, while others have time to regenerate. More information will be needed on the time it takes for certain NTFP species to regrow and at what rate of extraction can population levels be maintained. Furthermore, it might be important for such a system or policy to consider the different uses and functions of NTFPs. While some are extracted year-round for direct consumption, others are mainly collected in the dry season to sell on markets. A different approach might be needed for NTFPs with such different functions, both from a sustainable harvesting perspective and to increase the possible benefits to local livelihoods. For example, households specializing in selling better kola might benefit more from increased access to markets, while abundance of bush yams seems to be more important as a hunger food for vulnerable households. Initiatives that aim to commercialize certain NTFPs should also be cautious of the possible adverse consequences of unsustainable harvesting of the products they aim to promote.

From a social policy perspective, the fact that NTFPs are collected in different landscapes, not just in forests, might be good news. Abundance in different areas can make it easier for people to access NTFPs to meet their basic needs. It is difficult to say what function fulfilled by NTFPs is most important. While most households consume NTFPs, no conclusions can be drawn about the extent to which they rely on these products for sustenance. Some NTFPs might be highly important for nutrition diversity, such as bushmeat, vegetables and fruits. The importance of bush yams as staple supplement and hunger food is displayed by the large share of households collecting them, the fact that most are directly consumed instead of sold and that bush yam collection is correlated with food and health shocks. NTFPs can also be used to substitute consumption goods, for example in the case of building materials, which are most difficult to transport from markets to more remote villages.

Maintaining NTFP populations seems to be important for many households to sustain their livelihoods. Innovative solutions will be needed to address challenges posed by overharvesting and wildlife encroachment, such as that of red river hogs on bush yams. Next to the role of FUGs and co-management of local communities in sustainable harvesting, there might be options to domesticate certain NTFPs. For example, GRC and USAID have started a project on beekeeping, which teaches local communities to produce the equipment necessary for beekeeping and trains them in the techniques and knowledge needed for this activity. It is unclear at this point whether there is scope for other NTFPs to be cultivated. Both the question whether certain NTFPs lend themselves to cultivation and whether cultivating them generates enough economic benefits remain unclear. In the sample studied, most income is earned from products such as bitter kola, bush pepper, Guinea pepper and bush mangoes. They could lend themselves to further commercialization and potentially might be cultivated. Munro and Horst (2013) set out a brief business case for bitter kola which might be sold in urban markets and used in producing energy drinks, and bush pepper and Guinea pepper which could be marketed to expatriates in Freetown. They also note that bitter kola nuts and the bark of Camwood and *yogoi* bush stick tree could be sold on international markets as natural dyes. Several other NTFPs have been identified which could also have commercial potential, yet their collection (and income from these products) was not captured by the REDD data. They include bush attire (Mende: *nyenijagboi,* scientific: *massularia acuminata*), the seed of the fruit *kpei* and the root of the drumstick tree (Mende: *gbangei,* scientific: *cassia sieberiana*). For all of these NTFPs, a local market might need to be established first to get trade from Gola communities going and see what supply can be delivered. Commercialization could then be upscaled to include regional or international markets. Bushmeat sales also provide significant income for some households, which could be a sustainable source of income if species populations are maintained and local communities are aware of the protected species which are not to be hunted.

Even if NTFPs can be cultivated and produced on a large scale, there are a number of constraints to the role of NTFPs can play for income generation. For one, there has to be enough demand for certain NTFP products. The two biggest urban markets, namely Kenema and Freetown, have forests relatively nearby from which NTFPs can be harvested. The proximity of the Kambui Hills near Kenema and Western Area Peninsula near Freetown therefore reduce the demand for NTFPs from the Gola Rainforest (Munro and Horst 2013). Another obvious constraint is the lack of access to markets. As seen in the data, fewer households sell NTFPs if they live in villages from which it is more expensive to transport goods to markets. Since improved roads and cheaper transport option seem unlikely to be realized, most NTFP sales should be seen as a complementary income-earning activity. NGO's or private enterprises could help communities to get their NTFPs to markets, for example by acting as a centralized representative and marketing hub for the commercialization of the products. Something similar has been established with the establishment of a cocoa cooperative, with GRC guaranteeing fair and stable prices to farmers (personal communication 2019). Note, however, that cocoa has demand on international markets and cannot be compared to any of the NTFPs discussed. Nonetheless, combining transport of certain NTFPs and cultivated crops could increase the margins earned from NTFP sales as transport costs go down. The issue of lack of demand could be tackled by adding value through processing. Examples include producing medicinal potions and rattan products. Only sourcing the raw materials from forest communities and doing processing centrally can improve efficiency and supply, however it could also reduce the potential profit margin that goes to forest communities. NTFPs will also need to be promoted in larger markets to kickstart trade.

8. Conclusion

This study has explored the functions fulfilled by NTFPs in the livelihoods of forest communities living around the GRNP in Sierra Leone. NTFPs are important for both consumption and income generation. While most households collect and consume NTFPs, there is heterogeneity in the frequency of NTFPs collected and their uses. Moreover, only a smaller share of households is engaged with selling NTFPs, with a lot of variation in the importance that this plays in income generation. The evidence examined suggests that NTFPs can play a minor role in helping households deal with shocks, though there only is a clear relationship between food shortages and bush yam collection. In response to covariate shocks, engagement with NTFPs might actually be less likely, with households possibly choosing to allocate labor elsewhere.

Examining household and village data from a cross-sectional dataset obtained in 2019 has shown that nearly all households collected some NTFPs in the previous year and almost all these products were consumed. From the NTFPs which are used as foods, most are used as food supplement, condiment or snack, while bush yams are used as a staple food. Some NTFPs consumed as food have medicinal properties, while others are specifically collected to be used as medicine. Building materials were gathered most often and used to construct a variety of tools and buildings. A smaller share of NTFPs were sold, indicating that certain households specialize in marketing these products. While a few households gain the majority of their income from NTFPs, most use the sale of these products in a complementary manner. There are a number of NTFPs, such as kola nuts, bush pepper, honey, bush yams, and bush mango for which there is demand in local and urban markets, therefore bringing in some of the largest amounts of cash. There is also a significant share of bush meat sales, which brings in the highest income per household on average.

In general, most NTFPs were not gathered in primary forest, but in bush, farms and plantations. NTFP collection therefore seems to be a complementary activity for most households, which is combinable with their farm activities or done while travelling between the village, farms and market. Nonetheless, areas that are more isolated and with relatively more forest abundance are associated with a higher likelihood of collecting NTFPs. This is reflected in the regional variation in NTFP engagement with highly forested chiefdoms such as Malema and Nomo chiefdom experiencing most NTFP collection, while less forested and less isolated Barri had fewer households collecting these products. Households faced with higher costs to reach markets are less likely to sell NTFPs, potentially because the potential benefits from marketing NTFPs is reduced.

There seems to be a limited role played by NTFPs as a social safety-net. Most households dealt with idiosyncratic shocks by borrowing money or sold assets. Qualitative evidence suggests that bush yams are eaten as hunger foods to deal with food shortages, which is also reflected in the correlation with food shocks. Nevertheless, the correlations found with other shocks, as well as their interaction effects with forest abundance, transport cost to market and household education levels, might not indicate a direct relationship, so it is difficult to draw strong conclusions. In general, covariate shocks are correlated with lower a likelihood of collecting and selling NTFPs, which might point to households choosing more lucrative coping strategies than NTFP engagement. When considering NTFP categories separately, idiosyncratic shocks seem to be significantly positively correlated to the collection of certain NTFPs, while negative correlated with NTFP sales. Households wealthier in terms of assets are generally estimated to be more likely to sell NTFPs, however when they also experienced a covariate shock they are a little less likely to do so. These households tend to have more buffers and options for shock coping, such selling assets for example.

One of the major limitations to this study is the lack of data on quantities of NTFP collected, consumed and sold. Information on this would allow for an estimation of the magnitude of NTFP engagement and give a better understanding of its importance. Another important limitation is that no causal claims can be made on the basis of this research. While this study is the first to empirically examine the social safety-net function of NTFPs in the context of Sierra Leone, no definitive conclusions can be drawn regarding possible relationships between NTFP engagement and shocks. Even with these limitations, this work has given many potential avenues for future research and presented important policy implications. With regards to research implications, future studies could enhance the data collected regarding NTFPs, by surveying all household members, including data on quantities, and using improved measures for the source, sale and scarcity of NTFPs. More (qualitative) research can be done to enhance the understanding of NTFPs' social safety-net function, while experimental research could focus on the possible relationship between NTFP engagement and poverty alleviation and further explore NTFPs as a conservation tool. It is vital that the functioning of newly formed forest user groups is monitored to ensure that NTFPs stocks are being sustainably harvested. A central aspect in this process is more biological and ecological research to identify the location and size of NTFP species' populations and monitor changes. The latter is especially important for future initiatives that aim to commercialize NTFPs.

In terms of policy implications, the fact that NTFPs are mostly gathered outside of the primary forest should be included in conservation policies. The value of NTFPs might not be able to compete with clearing forests for other land uses, though the presence of NTFPs in forests and importance of these products to livelihoods can be presented to local communities as an argument not to do so. Commercializing NTFPs products has to be done with forest conservation objectives in mind, as NTFP species' populations could quickly be depleted without sustainable management. The detailed description of different NTFPs that is provided in this work can also directly be used in designing future policies and projects in the Gola context. Knowing which, where, how and why NTFPs are gathered is the first step in formulating an effective approach in efforts that try to conserve the forest and biodiversity and improve the livelihoods of local communities. The findings of this study have also shown the importance of establishing effective FUGs or other ways in which to include local communities in sustainably harvesting NTFPs, as many households benefit from the availability of these products.

GRC has made a lot of progress regarding research on NTFPs, educating local communities, and establishing FUGs. The next step is closely monitoring whether these efforts are having an impact on the sustainable harvesting of NTFPs. Any commercialization efforts should be preceded by effective institutions that make sure NTFP populations are not depleted. New initiatives could also explore whether certain high value NTFPs might be cultivated without clearing forest. That way they might still fit the definition of NTFP as used in this paper.

Bibliography

Akiwumi, Fenda A. 2014. "Strangers and Sierra Leone mining: cultural heritage and sustainable development challenges." *Journal of cleaner production* 84: 773-78.

Angelsen, Arild, Pamela Jagger, Ronnie Babigumira, Brian Belcher, Nicholas J. Hogarth, Simone Bauch, Jan Börner, Carsten Smith-Hall, and Sven Wunder. 2014. "Environmental income and rural livelihoods: a global-comparative analysis." *World Development* 64: S12-S28.

Arnold, John Edward Michael. 1994. *Nonfarm employment in small-scale forest-based enterprises: policy and environmental issues*. Working Paper #11. EPAT/MUCIA Research & Training, University of Wisconsin-Madison.

Arnold, John Edward Michael. 1995. "Society and Non-Timber Forest Products in Tropical Asia." In *Poverty & Conservation*. Ed. Fox J. Occasional paper No 19, East West Centre; Honolulu, Hawaii USA.

Babulo, Bedru, Bart Muys, Fredu Nega, Eric Tollens, Jan Nyssen, Jozef Deckers, and Erik Mathijs. 2009. "The economic contribution of forest resource use to rural livelihoods in Tigray, Northern Ethiopia." *Forest policy and Economics* 11, no. 2: 109-117.

Belcher, B. M., and P. Vantomme. 2003. "What isn't an NTFP?" *The International Forestry Review* 5, no. 2: 161-168.

Belcher, Brian, and Kathrin Schreckenberg. 2007. "Commercialisation of non-timber forest products: A reality check." *Development Policy Review* 25, no. 3: 355-377.

Cameron, A. Colin, and Douglas L. Miller. 2015. "A practitioner's guide to cluster-robust inference." *Journal of human resources* 50, no. 2: 317-372.

Carter, Michael R., and Christopher B. Barrett. 2006. "The economics of poverty traps and persistent poverty: An asset-based approach." *The Journal of Development Studies* 42, no. 2: 178-199.

Davies, A. G., Björn Schulte-Herbrüggen, Noëlle F. Kümpel, and Samantha Mendelson. 2007. "Hunting and trapping in Gola Forests, South-Eastern Sierra Leone: bushmeat from farm, fallow and forest." *Bushmeat and Livelihoods: Wildlife Management and Poverty Reduction*: 15-31.

Davies, Glenn and Paul Richards. 1991. "Rainforest in Mende life: Resources and subsistence in rural communities in the Gola North Forest Reserve (Sierra Leone)." Report to ESCOR, UK Overseas Development Administration, London.

De Beer, Jenne H. and Melanie J. McDermott. 1989. *The economic value of non-timber forest products in Southeast Asia: with emphasis on Indonesia, Malaysia and Thailand*. Netherlands Committee for IUCN, Amsterdam.

Debela, Bethelhem, Gerald Shively, Arild Angelsen, and Mette Wik. 2012. "Economic shocks, diversification, and forest use in Uganda." *Land Economics* 88, no. 1: 139-154.

Dokken, Therese and Arild Angelsen. 2015. "Forest reliance across poverty groups in Tanzania." *Ecological economics* 117: 203-211.

Dove, Michael R. 1994. “Marketing the rainforest: ‘green’ panacea or red herring?” *Asia-Pacific Issues*, No. 13. East-West Center, Hawaii.

Endamana, D., K. A. Angu, G. N. Akwah, G. Shepherd, and B. C. Ntumwel. 2016. "Contribution of non-timber forest products to cash and non-cash income of remote forest communities in Central Africa." *International forestry review* 18, no. 3: 280-295.

Evans, M. I. 1993. *Conservation by commercialization*. Pages 815–822 *in* Hladik, Claude Marcel, Annette Hladik, Olga F. Linares, Hélène Pagezy, Alison Semple, and Malcolm Hadley eds. *Tropical forests, people and food: biocultural interactions and applications to development.* MAB Series, Volume 13. UNESCO, Paris and Parthenon, Carnforth, UK.

Fisher, Monica, Moushumi Chaudhury, and Brent McCusker. 2010. "Do forests help rural households adapt to climate variability? Evidence from Southern Malawi." *World Development* 38, no. 9: 1241-1250.

Fisher, Monica. 2004. "Household welfare and forest dependence in Southern Malawi." *Environment and Development Economics* 9, no. 2: 135-154.

Forestry Division. 2009. *Gola Forest Reserves – the proposed Gola Forest National Park. Management Plan 2007-2012.* The Royal Society for the Protection of Birds, Sandy, UK. Conservation Society of Sierra Leone, Freetown, Sierra Leone. Forestry Division, Ministry of Agriculture, Forestry and Food Security, Freetown, Sierra Leone.

Foster, William, Alberto Valdés, Benjamin Davis, and Gustavo Anríquez. 2011 "The constraints to escaping rural poverty: An analysis of the complementarities of assets in developing countries." *Applied Economic Perspectives and Policy* 33, no. 4: 528-565.

Friedline, Terri, Rainier D. Masa, and Gina AN Chowa. 2015. "Transforming wealth: Using the inverse hyperbolic sine (IHS) and splines to predict youth’s math achievement." *Social science research* 49: 264-287.

Ghate, Rucha, Deepshikha Mehra, and Harini Nagendra. 2009. "Local institutions as mediators of the impact of markets on non-timber forest product extraction in central India." *Environmental Conservation* 36, no. 1: 51-61.

Haines-Young, Roy and Marion B. Potschin. 2018. “Common International Classification of Ecosystem Services (CICES) V5.1: Guidance on the Application of the Revised Structure.” Fabis consulting, Nottingham.

Hansen, Matthew C., Peter V. Potapov, Rebecca Moore, Matt Hancher, Svetlana A. Turubanova, Alexandra Tyukavina, and David Thau. 2013. "High-resolution global maps of 21st-century forest cover change." *science* 342, no. 6160: 850-853.

Heubach, Katja, Rüdiger Wittig, Ernst-August Nuppenau, and Karen Hahn. 2011. "The economic importance of non-timber forest products (NTFPs) for livelihood maintenance of rural west African communities: A case study from northern Benin." *Ecological Economics* 70, no. 11: 1991-2001.

Homma, Alfredo Kingo Oyama. "The dynamics of extraction in Amazonia: a historical perspective." *Advances in Economic Botany* (1992): 23-31.

Jagger, Pamela. 2014. "Confusion vs. clarity: Property rights and forest use in Uganda." *Forest Policy and Economics* 45: 32-41.

Jahnke, Hans E., and Hans Eberhard Jahnke. 1982. *Livestock production systems and livestock development in tropical Africa*. Vol. 35. Kiel: Kieler Wissenschaftsverlag Vauk.

Jucker, Tommaso, Aida Cuni Sanchez, Jeremy A. Lindsell, Harriet D. Allen, Gabriel S. Amable, and David A. Coomes. 2016. "Drivers of aboveground wood production in a lowland tropical forest of West Africa: teasing apart the roles of tree density, tree diversity, soil phosphorus, and historical logging." *Ecology and evolution* 6, no. 12: 4004-4017.

Kalaba, Felix Kanungwe, Claire Helen Quinn, and Andrew John Dougill. 2013. "The role of forest provisioning ecosystem services in coping with household stresses and shocks in Miombo woodlands, Zambia." *Ecosystem Services* 5: 143-148.

Kamanga, Penjani, Paul Vedeld, and Espen Sjaastad. 2008. "Forest incomes and rural livelihoods in Chiradzulu District, Malawi." *Ecological Economics* 68, no. 3: 613-624.

Kar, S. P., and Michael Gregory Jacobson. 2012. "Market constraints in NTFP trade: household perspectives in Chittagong Hill Tracts of Bangladesh." *International Forestry Review* 14, no. 1: 50-61.

Kumar, L. B., B. L. Patil, H. Basavaraja, S. M. Mundinamani, S. B. Mahajanashetty, and S. N. Megeri. 2011. "Participation behavior of indigenous people in non-timber forest products extraction in western ghats forests." *Karnataka Journal of Agricultural Sciences* 24, no. 2.

Kusters, Koen, Ramadhani Achdiawan, Brian Belcher, and Manuel Ruiz Pérez. 2006. "Balancing development and conservation? An assessment of livelihood and environmental outcomes of nontimber forest product trade in Asia, Africa, and Latin America." *Ecology and Society* 11, no. 2.

Lea Ravnkilde Møller, Carsten Smith-Hall, Henrik Meilby, Santosh Rayamajhi, Lise Byskov Herslund, Helle Overgaard Larsen, Øystein Juul Nielsen & Anja Byg. 2019. "Empirically based analysis of households coping with unexpected shocks in the central Himalayas." *Climate and Development* 11: no. 7: 597-606.

Leach, Melissa. 1994. *Rainforest relations: gender and resource use among the Mende of Gola, Sierra Leone*.

Lebbie, Aiah R., and Raymond P. Guries. 2002. "The palm wine trade in Freetown, Sierra Leone: production, income, and social construction." *Economic botany* 56, no. 3: 246-254.

Lepcha, Lakpa Doma, Gopal Shukla, Nazir Ahmad Pala, Vineeta, Prabhat Kumar Pal, and Sumit Chakravarty. 2018. "Contribution of NTFPs on livelihood of forest-fringe communities in Jaldapara National Park, India." *Journal of Sustainable Forestry* 38, no. 3: 213-229.

Manning, Ryann Elizabeth. 2009. "The Landscape of Local Authority in Sierra Leone: How 'Traditional' and 'Modern' Justice and Governance Systems Interact." *The World Bank Justice & Development working paper series*, volume 1 issue 1.

Marshall, E., K. Schreckenberg, and A. C. Newton. 2006. "Commercialisation of Non-timber Forest Products: Factors Influencing Success. Lessons Learned from Mexico and Bolivia and Policy Implications for Decision-makers." *International Forestry Review* 8, no. 3: 368-369.

Mcelwee, Pamela D. 2008. "Forest environmental income in Vietnam: household socioeconomic factors influencing forest use." *Environmental conservation* 35, no. 2: 147-159.

McGarry, Dylan K., and Charlie M. Shackleton. 2009. "Children navigating rural poverty: Rural children's use of wild resources to counteract food insecurity in the Eastern Cape, South Africa." *Journal of Children and Poverty* 15, no. 1: 19-37.

McSweeney, Kendra. 2004. "Forest product sale as natural insurance: the effects of household characteristics and the nature of shock in eastern Honduras." *Society and Natural Resources* 17, no. 1: 39-56.

Michon, Geneviève. 2005. "NTFP Development and Poverty Alleviation: Is the Policy Context Favourable?" *Non-Timber Forest Products between poverty alleviation and market forces*: 20-25.

Mokuwa, Esther, Maarten Voors, Erwin Bulte, and Paul Richards. 2011. "Peasant grievance and insurgency in Sierra Leone: judicial serfdom as a driver of conflict." *African Affairs* 110, no. 440: 339-366.

Mulenga, Brian P., Robert B. Richardson, Lawrence D. Mapemba, and Gelson Tembo. 2011. "The contribution of non-timber forest products to rural household income in Zambia." *Food security research project* working paper, No. 54.

Mulungu, Kelvin and Dale Manning. 2019. "Weather Shocks and Nutrition Protection: the Role of Forests." Colorado State University Selected Paper prepared for presentation at the 2019 Agricultural & Applied Economics Association Annual Meeting, Atlanta, GA, July 21-23.

Munro, Paul and Greg van der Horst. 2013. "The Role of Non-Timber Forest Products (NTFPs) in Community Livelihoods around the Gola Forest National Park and Tiwai Island Wildlife Sanctuary: Current uses and future possibilities." *Welt Hunger Hilfe, Environmental Foundation for Africa and the European Union*.

Munro, Paul, Greg van der Horst, and Stephen Healy. 2017. "Energy justice for all? Rethinking sustainable development goal 7 through struggles over traditional energy practices in Sierra Leone." *Energy Policy* 105: 635-641.

Myers, Norman, Russell A. Mittermeier, Cristina G. Mittermeier, Gustavo AB Da Fonseca, and Jennifer Kent. 2000. "Biodiversity hotspots for conservation priorities." *Nature* 403, no. 6772: 853-858.

North, Douglass C. 1990. *Institutions, institutional change, and economic performance*. Cambridge: Cambridge University Press.

Organisation for Economic Co-operation and Development. 2011. *Divided we stand: Why inequality keeps rising*. Paris: OECD publishing.

Osemeobo Gbadebo J. and Gloria Ujor. 1999. "The non-wood forest products of Nigeria." EC-FAO Partnership Programme (1998-2000) – Project GCP/INT/679/EC Data Collection and

Analysis for Sustainable Forest Management in ACP Countries – Linking National and International Efforts. FAO, Rome.

Pattanayak, Subhrendu K., and Erin O. Sills. 2001. "Do tropical forests provide natural insurance? The microeconomics of non-timber forest product collection in the Brazilian Amazon." *Land economics* 77, no. 4: 595-612.

Paumgarten, F., and C. M. Shackleton. 2009. "Wealth differentiation in household use and trade in non-timber forest products in South Africa." *Ecological Economics* 68, no. 12: 2950-2959.

Paumgarten, Fiona. 2007. "The significance of the safety-net role of NTFPs in rural livelihoods, South Africa." PhD diss., Rhodes University.

Peters, Charles M. 1994. "Sustainable harvest of non-timber plant resources in tropical moist forest: an ecological primer." Biodiversity Support Program, World Wildlife Fund, Washington, DC.

Peters, Krijn, and Paul Richards. 2011. "Rebellion and agrarian tensions in Sierra Leone." *Journal of Agrarian Change* 11, no. 3: 377-395.

Quang, Dang Viet, and Tran Nam Anh. 2006. "Commercial collection of NTFPs and households living in or near the forests: Case study in Que, Con Cuong and Ma, Tuong Duong, Nghe An, Vietnam." *Ecological economics* 60, no. 1: 65-74.

Rahut, Dil Bahadur, Bhagirath Behera, and Akhter Ali. "Do forest resources help increase rural household income and alleviate rural poverty? Empirical evidence from Bhutan." *Forests, Trees and Livelihoods* 25, no. 3 (2016): 187-198.

Richards, Paul, Joseph Amara, Mariane C. Ferme, Prince Kamara, Esther Mokuwa, Amara Idara Sheriff, Roland Suluku, and Maarten Voors. 2015. "Social pathways for Ebola virus disease in rural Sierra Leone, and some implications for containment." *PLoS neglected tropical diseases* 9, no. 4: e0003567.

Rigg, Jonathan. 1988. "Land ownership and land tenure as measures of wealth and marginalisation: evidence from Northeast Thailand." *Area*: 339-345.

Rothstein, Bo, and Dietlind Stolle. 2008. "The state and social capital: An institutional theory of generalized trust." *Comparative politics* 40, no. 4: 441-459.

Royal Society of Bird Protection (RSPB). 2015. “The Gola REDD project: Project description following the Climate, Community and Biodiversity Alliance Standards (Second addition).” Project document prepared on behalf of the Gola Rainforest Conservation LG. Retrieved from: http://www.climate-standards.org/2014/01/06/gola-redd-project/.

Saha, Debabrata, and R. C. Sundriyal. 2011. "Utilization of non-timber forest products in humid tropics: Implications for management and livelihood." *Forest Policy and Economics* 14, no. 1: 28-40.

Sander, Klas, and Manfred Zeller. 2007. "Protected area management and local benefits—a case study from Madagascar." In *Stability of tropical rainforest margins*, pp. 363-385. Springer, Berlin, Heidelberg.

Saura, Santiago, Örjan Bodin and Marie-Josée Fortin. 2014. “Stepping stones are crucial for species’ long-distance dispersal and range expansion through habitat networks.” *Journal of Applied Ecology* 51, no. 1: 171-182.

Schreckenberg K, Rushton J, te Velde DW. 2006. “NTFP value chains: what happens between production and consumption?” In: Marshall E, Schreckenberg K, Newton AC (eds) *Commercialisation of non-timber forest products: factors influencing success*. UNEP, Cambridge, UK.

Schreckenberg, Kathrin. 2004. “The contribution of shea butter to local livelihoods in Benin.” In*: S*underland, T. and Ndoye, O. (eds.) *Forest products, livelihoods and conservation: case studies of non-timber forest product systems, Volume 2 – Africa,* pp. 91-113. Center for International Forestry Research, Bogor, Indonesia.

Shackleton, Charlie and Sheona Shackleton. 2004. “The importance of non-timber forest products in rural livelihood security and as safety nets: a review of evidence from South Africa.” *South African Journal of Science* 100**,** no. 11: 658-664.

Shackleton, Charlie, and Sheona Shackleton. 2003. "Value of non-timber forest products and rural safety nets in South Africa." In *International Conference on Rural Livelihoods, Forests and Biodiversity*, pp. 19-23.

Shackleton, Charlie, Claudio O. Delang, Sheona Shackleton, and Patricia Shanley. 2011a. “Non-timber Forest Products: Concept and Definitions.” In *Non-timber forest products in the global context*, edited by Shackleton, Sheona, Charlie Shackleton, and Patricia Shanley, Tropical Forestry No.7. Amsterdam: Springer-Verlag Berlin Heidelberg.

Shackleton, S. E., C. M. Shackleton, T. R. Netshiluvhi, B. S. Geach, A. Ballance, and D. H. K. Fairbanks. 2002. "Use patterns and value of savanna resources in three rural villages in South Africa." *Economic Botany* 56, no. 2: 130-146.

Shackleton, Sheona, Claudio O. Delang, and Arild Angelsen. 2011b. “From Subsistence to Safety Nets and Cash Income: Exploring the Diverse Values of Non-timber Forest Products for Livelihoods and Poverty Alleviation.” In *Non-timber forest products in the global context*, edited by Shackleton, Sheona, Charlie Shackleton, and Patricia Shanley, Tropical Forestry No.7. Amsterdam: Springer-Verlag Berlin Heidelberg.

Sunderland, Terry, Ramadhani Achdiawan, Arild Angelsen, Ronnie Babigumira, Amy Ickowitz, Fiona Paumgarten, Victoria Reyes-García, and Gerald Shively. 2014. "Challenging perceptions about men, women, and forest product use: a global comparative study." *World Development* 64: 56-66.

The Useful Tropical Plants Database. 2020. http://tropical.theferns.info/.

Ticktin, Tamara, and Charlie Shackleton. 2011. "Harvesting non-timber forest products sustainably: opportunities and challenges." In *Non-timber forest products in the global context,* pp. 149-169. Springer, Berlin, Heidelberg.

Ticktin, Tamara. 2004. "The ecological implications of harvesting non-timber forest products." *Journal of Applied Ecology* 41, no. 1: 11-21.

Timko, J. A., P. O. Waeber, and R. A. Kozak. 2010. "The socio-economic contribution of non-timber forest products to rural livelihoods in Sub-Saharan Africa: knowledge gaps and new directions." *International forestry review* 12, no. 3: 284-294.

Van den Berg, Jolanda, K. Freerk Wiersum, and Han van Dijk. 2007. "The role and dynamics of community institutions in the management of NTFP resources." *Forests, Trees and Livelihoods* 17, no. 3: 183-197.

Vedeld, Paul; Angelsen, Arild; Sjaastad, Espen; Kobugabe Berg, Gertrude. 2004. *Counting on the environment: forest incomes and the rural poor*. Environmental economic paper series ; no. 98. Washington, DC: World Bank. http://documents.worldbank.org/curated/en/825651468778804896/Counting-on-the-environment-forest-incomes-and-the-rural-poor

Völker, Marc, and Hermann Waibel. 2010. "Do rural households extract more forest products in times of crisis? Evidence from the mountainous uplands of Vietnam." *Forest Policy and Economics* 12, no. 6: 407-414.

Walelign, Solomon Zena, Martin Reinhardt Nielsen, and Helle Overgaard Larsen. "Environmental Income as a Pathway Out of Poverty? Empirical Evidence on Asset Accumulation in Nepal." 2019. *The Journal of Development Studies* 55, no. 7: 1508-1526.

Walelign, Solomon Zena. "Forests beyond income: The contribution of forest and environmental resources to poverty incidence, depth and severity." *International Journal of AgriScience* 3, no. 7 (2013): 533-542.

Wilebore, B., Voors, M., Bulte, E., Coomes, D., & Kontoleon, A. 2019. “Unconditional Transfers and Tropical Forest Conservation: Evidence from a Randomized Control Trial in Sierra Leone.” *American Journal of Agricultural Economics* 101, no. 3: 894-918.

Wunder, Sven, Jan Börner, Gerald Shively, and Miriam Wyman. 2014. "Safety nets, gap filling and forests: a global-comparative perspective." *World Development* 64: S29-S42.

Yongneng Fu , Jin Chen , Huijun Guo , Huabin Hu , Aiguo Chen & Jingyun Cui. 2009. “Rain forest dwellers' livelihoods: income generation, household wealth and NTFP sales, a case study from Xishuangbanna, SW China.” *International Journal of Sustainable Development & World Ecology* 16, no. 5: 332-338.

Zellner, Arnold. 1962 "An efficient method of estimating seemingly unrelated regressions and tests for aggregation bias." *Journal of the American statistical Association* 57, no. 298: 348-368.

Zhu, Hongge, Shilei Hu, Yue Ren, Xing Ma, and Yukun Cao. 2017. "Determinants of engagement in non-timber forest products (NTFPs) business activities: A study on worker households in the forest areas of Daxinganling and Xiaoxinganling Mountains, northeastern China." *Forest Policy and Economics* 80: 125-132.

Appendix I – Composition of asset index

The variable *asset index* is composed of several durable and productive assets. A bed was taken as the base value, with the other types of assets coded as partial or multiple beds. Most households own multiple assets, some own multiple of each type. The value of these assets in comparison to the value of a bed was estimated using insights from fieldwork conducted in local communities in several villages around the GRNP. Table x shows the assets that were included with their respective weight.

Table x: Composition of asset index

Asset	Weight
Bed	1
Table	0.5
Chair	0.7
Big pot	1.5
Bucket	0.5
Hoe	0.8
Axe	0.8
Cutlass	1.2
Watering can	0.4
Fishing net	0.8
Bible or Koran	0.8
Bed net	0.4
Mobile phone	2
Radio	1.8

Appendix II - NTFP types, names and characteristics

Hunted and trapped food

English	Mende	Scientific name	Use	Collected where	Who collects	Collected when	Scarcity	Consumption or sale	Price and marketing
Monkeys	Kuagaa (general)	*Various species*	Bushmeat	Mostly on farms/plantations (around 50%)*	Collected by 7% of HH*	-	Little (18%)*	Mostly consumption (75%)*	-
Birds	Honni (general)	*Various species*	Bushmeat	-	Less than 1% of HH in 2014** and none collected in 2019*	-	-	Consumption**	-
Fish	Nyei (general)	*Various species*	Bushmeat	Mostly in community forest (around 50%).* The 2013 survey suggests mostly in swamps (around 80%)**	Collected by 4% of HH.* Fishing is done by women	Dry season as water level drops and fish are easier to catch	Little (12%)*	Mostly consumption (77%)*	-
Reptiles		*Various species*	Bushmeat	Mostly on farms/plantations (around 65%)*	Collected by 1% of HH*	-	Yes (50%)*	Mostly consumption (83%) *	-
Snake	Kali								
Crocodile	Kugbeh								
Tortoise	Haque								
Rodents			Bushmeat	Mostly on farms/plantations (around 61%)*	Collected by 34% of HH*	Trapped in rainy season	Little (15%)*	Mostly consumption (81%)*	-
Giant forest squirrel	Bofi	*Protoxerus stranger*							
Red-legged squirrel	Bovie	*Heliosciurus rufobrachium*							
Giant rat	Kulue/ kailue	*Cricetomys gambianus*							
Cutting grass/ cane rat	Sewulo/ seulu	*Thyronomis swinderianus*							
Ground pig	Kuwui	*Unknown*							
Porcupine	Sejeeh/ senje	*Atherurus africanus* *Hystrix cristata*	Bushmeat	Mostly on farms/plantations (55%)*	Collected by 16% of HH*	-	Little (19%)*	Mostly consumption (82%)*	-
Duikers			Bushmeat	Mostly in community forest (around 40%) and old bush (around 35%)*	Collected by 1% of HH*	Hunted in dry season	Somewhat (33%)*	Both (consumption 67%)*	-
Maxwell duiker	Kpoka huen	*Philantomba maxwellii*							
Black duiker	Taowuli	*Cephalophus niger*							
Royal antelope	Hagbe/ hagnewuie	*Neotragus pygmaeus*	Bushmeat	Mostly on farms/plantations (around 55%)*	Collected by 1% of HH*	-	No (9%)*	Both (consumption 55%)*	-
Bush hog/ red river hog	Ndodeh	*Potamochoerus porcus*	Bushmeat	Mostly on farms/plantations (around 75%)*	Collected by 3% of HH*	-	Somewhat (25%)*	Both (consumption 33%)*	-
Bushbuck	Ndopa	*Tragelaphus scriptus*	Bushmeat	-	-	-	-	-	-

Vegetables

English	Mende	Scientific name	Use	Collected where	Who collects	Collected when	Scarcity	Processed	Consumption or sale	Price (adjusted for inflation†) and marketing	Notes
Leaf	Popondaa	*Piper umbellatum*	Leaf used in sauces for sweet flavor	Mostly in old and new bush (around 30% each)*	Collected by 20% of HH.* More often collected by women†	All year	Little (20%)*	-	Mostly consumption (96%)*	Le 1,000 per bundle†	Commonly sold in local markets
Leaf	Gbohui	*Triumfetta cordifolia*	Leaf used in sauces.	Mostly in new bush (around 45%)*	Collected by 6% of HH*	-	Little (23%)*	-	Mostly consumption (94%)*	-	Plant also used to make rope
Gingerroot	Kinjei	*Zingiber*	Common gingerroot, which is used to make tea or in preparing food. Also used as medicine	Mostly in new bush (around 50%)*	Collected by 2% of HH.* Men and women collect it†	Seasonal, late dry season	Somewhat (29%)*	-	Mostly consumption (94%)*	-	Commonly sold in markets
Alligator pepper (seed)	Kponi-gije/ poni/ ponekeje	*Aframomum melegueta*	Seeds have black-pepper-like flavor used in cooking. Part of plant used for treating headaches	-	-	-	-	-	-	-	-
Seed	Helei	*Bussea occidentalis*	Seeds are roasted and used for consumption and as medicine. Similar flavor to peanut.	Mostly in community forest (around 55%)*	Collected by 3% of HH.* Men and women collect it†	Seasonal, mainly dry season	Little (21%)*	Dried/roasted or ground down	Mostly consumption (79%)*	Le 2,000-6,000 per cup. Mostly sold in weekly market†	-
Glossy nightshade (leaf)	Kimbei	*Solanum nodiflorum*	Leaf used in sauces. Also has medicinal uses	Mostly equal between new bush and community forest (around 30%)*	Collected by 4% of HH*	-	Little (21%)*	-	Mostly consumption (88%)*	-	-
Bitter kola	Sagbei	*Garcinia kola*	Mainly used as male aphrodisiac. Nut is also chewed for energy as it is rich in caffeine. In ceremonies it has traditionally been offered as a gift to the chief. Other medicinal uses include against body pain, cough, malaria, mild stomachache, worms and to prevent vomiting	Mostly on farm/plantation (around 75%)*	Collected by 6% of HH.* Both men and women collect it and find it important†‡	Seasonal, (late) dry season	Somewhat (27%)*	Dried in the sun and stored in bags	Both (consumption 41%)*	Le 500-1,000 a piece, Le 5,000-10,000 per cup†‡. Most people sell in Kenema market, but also weekly market and in village	It has commercial potential, but sometimes is harvested unsustainably. E.g. tree is cut down for harvesting. Otherwise people wait for fruit to fall from the tree
Bush pepper	Gbahein/ mbahein	*Piper guineense*	Vine which produces fruit that can be dried and used like black pepper. Medicinal uses of stem include treating body pain, colds, fever, headaches and menstruation pain	Distributed between bush, community forest and farm/ plantation, but mostly collected in new bush (around 35%)*	Collected by 5% of HH.* Men find most important†	Seasonal, dry season	Somewhat (36%)*	Dried	Both (consumption 53%)*	Le 15,000 per cup.‡ Mostly sold within village, also some in Kenema†	It has commercial potential, yet often harvested unsustainably. Tree on which vine grows or vine itself is often cut down for harvesting. Improved harvesting techniques include sticking a needle in the vine when fruits are mature and they will fall down. This does not kill the plant

Vegetables continued

English	Mende	Scientific name	Use	Collected where	Who collects	Collected when	Scarcity	Processed	Consumption or sale	Price (adjusted for inflation†) and marketing	Notes
Seed	Kpei	*Coelocaryon sp.*	Tree produces sweet edible fruit. Seeds can be roasted, ground into a powder and added as a condiment and enrichment to soups/sauces. Various parts of the tree have medicinal uses	Mostly in community forest†	Women‡	Seasonal, dry season	Yes†	Fruits pounded for treatment of various ailments. Seeds roasted and grounded into powder	Both†	Le 2,000-10,000 per cup.‡ Most sell at weekly market, some to traders.†	It has commercial potential
Seed	Gba	*Beilschmiedia mannii*	Condiment to soups, rice and vegetables	Swampy areas	All	Dry season	-	Dried and ground, sometimes stored undried for future use	-	-	-
Seed	Yawi	*Heritiera utilis*	Similar to groundnut (peanut) and used in soups/sauces. Tree also has medicinal uses	Found in GRNP‡	Women‡	Seasonal, dry season	-	Seed grounded into powder and used in sauces	-	Le 2,000-3,000 per cup †	-
Leaf	Kpohun	*Triumfetta tomentosa*	Bark and stem used in soups and sauces. Also has medicinal uses and can be used to make rope	-	Mostly collected by women†	-	Little†	-	Consumption†	-	Bark and stem are a source of mucilage used to make slimy sauces
Mullein nightshade/ bush Maggi	Gogodi/ kposi	*Solanum verbascifolium*	Leaf used to flavor sauces, has a similar taste to the stock cube 'Maggi'	-	Only two households*	-	-	-	-	-	-

Fruits											
English	**Mende**	**Scientific name**	**Use**	**Collected where**	**Who collects**	**Collected when**	**Scarcity**	**Processed**	**Consumption or sale**	**Price (adjusted for inflation†) and marketing**	**Notes**
Bush mango	Borboi/ bobo	*Irvingia gabonensis*	Edible mango-like fruits, which also contain seeds which can be eaten. Fruit used to encourage digestion.	Mostly equal in community forest and old bush (around 40% each)*	Collected by 16% of HH*	Seasonal, dry season	Somewhat (31%)*	Seed roasted or pressed to produce oil	Mostly consumption (82%)*	Le 10,000 per cup‡ Le 1,000 per 4 pieces in Kenema market	Monkeys also like the fruit, which creates competition
Herb	Kikpoi	*Crassocephalum crepidioides*	Leaf used in sauces and parts of plant have medicinal uses	Mostly in new bush (65%)*	Collected by 10% of HH*	Seasonal, early dry season	Little (23%)*	-	Mostly consumption (95%)*	-	-
Guinea plum	Dawei	*Parinari excelsa*	Sweet edible fruit	Mostly in community forest (around 40%)*	Collected by 6% of HH.* Women collect more often than men†	Seasonal, dry season	Little (15%)*	-	Mostly consumption (94%)*	Le 1,00 per cup†	People sometimes eat it while working to shortly reduce hunger
Oil bean tree	Fawei/ fawa	*Pentaclethra macrophylla*	Seeds used to produce oil or eaten; bark used for treating worms, gonorrhea, anti-inflammation, and other medicinal proposes	Mostly in community forest (45%)*	Collected by 7% of HH.* Men and women collect†	Seasonal, dry season	Little (21%)*	Bark peeled, soaked and drunk; seeds are roasted and eaten or pressed to produce oil	Mostly consumption (90%)*	Le 6,000 per cup. Some is sold in weekly market†	-
Fruit (“Guinea pepper’)	Hewei	*Xylopia aethiopica*	Fruit contains seeds which are used as pepper. Fruit and leaves have many medicinal uses, such as treating body pain, colds, coughing, fever, head aches, worms, menstruation pain and stomach aches	Mostly equal in old bush and community forest (around 35% each)*	Collected by 3% of HH.* Men and women collect†	Seasonal	Little (19%)*	Leaves boiled and drunk against colds and dysentery or mashed with pestle and mortar and rubbed on skin to treat wounds. Stem also chewed	Both (consumption 55%)*	Le 2,000-5000 per cup. Le 60,000-200,000 per bag. Mostly sold to traders, some in weekly market and in village†	Demand for unripe green fruit on market, consequentially the tree is often cut down entirely. Suggestion is to use harvesting knife when climbing tree
Sugar plum	Kondi/ kodie	*Uapaca guineensis*	Sweet edible fruit	Mostly in community forest (50%).*	Collected by 1% of HH.* Men collect more often than women†	Seasonal	Little (13%)*	-	Mostly consumption (88%)*	Le 1,000 per pile.†	-
Kola fruit	Bunni/ bunie	*Cola lateritia*	Sweet edible fruit. Seed is not chewed like other kola nuts. Eaten as appetizer or when come across	Mostly community forest.† Also grows closer to streams‡	Women†	Seasonal†	Yes†	-	Both, but more for consumption†	Le 1,000 per piece. Some is sold in weekly market, village and Kenema†	-

Fruits continued

English	Mende	Scientific name	Use	Collected where	Who collects	Collected when	Scarcity	Processed	Consumption or sale	Price (adjusted for inflation†) and marketing	Notes
Fruit/ seed	Kifei/ kafei	*Leconodiscus cupanioides*	Used to treat malaria and impotence, also produces sweet edible fruit.	Community forest†	Collected by only 1 HH*	Seasonal	No†	Bark is boiled and drunk	Consumption†	-	-
Bush banga	Ndoku-wuli/ dukuwuli	*Diospyros thomasii*	Sweet edible fruit, also used as medicine for gonorrhea and parts of plant for making traps	Mostly in community forest and bush†	Men and women†	-	No†	-	Both, but more for consumption†	Le 2,000 a piece†	-
Tree	Gboji	*Lannea Nigritana*	Edible fruit, bark has medicinal uses. Also used to produce scented cosmetic rubbed on body	Mostly in community forest†	Men and women†	Seasonal†	Somewhat†	-	Both†	Le 2,000 per cup. Some sold to traders, some in Kenema†	-
Velvet tamarind	Mamboi	*Dialium guineense*	Edible fruit, plant also has medicinal uses.	Mostly community forest†	Men and women†	Seasonal†	Somewhat†	-	Both†	Le 1,000 per bundle. Mostly sold to traders, some in Kenema and weekly market†	-
Fruit	Gigboi	*Salacia senegalensis*	-	Community forest and GRNP‡	-	-	-	-	-	-	Eaten when come across
Brumston/ African peach	Yubuiyambay/ Ubuyabei	*Nauclea latifolia*	Sweet edible fruit. Also used to treat malaria	Mostly bush, also community forest.†	Many people find it important, more women than men†	All year†	Little†	-	Both, but mostly consumption†	Le 1,000 -2,000 per bundle†	-
Breadfruit/ jackfruit	Befui	*Artocarpus altilis*	Produces large fruit that can be eaten raw (when ripe) or cooked	Mostly in bush.†	Men and women find important†	Seasonal†	Somewhat†	-	Consumption†	Le 2,000 a piece.†	-
Wild oil palm	Tokpo	*Elaeis guineensis*	Fruit are used to make palm oil	-	Collected by men and processed by women	-	-	-	-	-	-
Bush orange	Ndogbo- lube	-	Used in cooking or drinks	-	-	-	-	-	-	-	-
Bush pineapple	Ndogbo-nessie	-	Sweet edible fruit	-	-	-	-	-	-	-	-
Bush banana	Ndogbo-njaie	-	Sweet edible fruit	-	-	-	-	-	-	-	-

Building materials

English	Mende	Scientific name	Use	Collected where	Who collects	Collected when	Scarcity	Processed	Consumption or sale	Price (adjusted for inflation†) and marketing	Notes
Bush stick	Kandi	*Anisophyllea laurina*	Used as building poles, rafters and making pestles	Mostly in old bush (around 65%)*	Collected by 49% of HH*	All year	No (9%)*	-	Consumption (100%)*	-	The tree also has plum-like fruit which are sold in markets
Bush stick	Yogoi/ yougoi	*Harungana madagascariensis*	Used for hut rafters and beams but also has medicinal uses	Mostly in old (around 40%) and new (around 35%) bush*	Collected by 3% of HH.* Men collect more often than women†	All year	No (0%)*	-	Consumption†	-	Sticks are sometimes used to kill snakes
Other sticks	Haway; pudoi; tijui; kpaia	*Various species*	Construction	Mostly in old bush (around 55%)*	Collected by 13% of HH*	-	No (3%)*	-	Consumption†	-	-
Board (red hard wood)	Yawi	*Heritiera utilis*	Construction	Mostly in old bush and community forest (both around 40%)*	Collected by 7% of HH.* Men and women find it important†	-	Little (17%)*	-	Consumption (100%)*	-	
Board (white soft wood)	Baji	*Terminalia ivorensis*	Construction, making mortars	Mostly in old bush (around 40%) and community forest (35%)*	Collected by 5% of HH.* Men find it most important†	All year	Somewhat (27%)*	-	Consumption (100%)*	-	-
	Semei	*Chlorophora regia*									
Thatch	Njasei	*Raphia hookeri*	Main use is roofing, but parts of the tree are also used to make mats, (fish) traps, baskets, bags, rope, hammocks, and ceremonial costumes	Mostly in swamps (around 90%)*	Collected by 71% of HH.* Men find it most important†	All year	No (7%)*	-	Consumption (100%)*	-	-
	Manie	*Raffia palm*	Used to make fishing nets, traps, chicken baskets, mats and other equipment								

Building materials continued

English	Mende	Scientific name	Use	Collected where	Who collects	Collected when	Scarcity	Processed	Consumption or sale	Price (adjusted for inflation†) and marketing	Notes
Rattan	Balui/ mbalue	*Eremospatha macrocarpa*	Used to make furniture, baskets, mats, (fish) traps, rope, harnesses for climbing trees and rice winnowing fanners	Mostly in old bush (around 45%) and community forest (40%).*	Rattan is collected by 27% of HH.* Men find it most important.†	All year	Little (18%)*	Placed in sun to dry; before use soaked in water to loosen	Mostly consumption (98%)*, however this underestimates the commercial value put on rattan products	Le 20,000 per bundle. Le 10,000 for a medium sized basket.‡ Mostly sold in weekly market and village, some to traders†	High commercial potential, but in some places increasingly scarce
	Kavui	*Laccosperma secundiflorum*									
Bamboo	Ndovui	-	Construction, leaves also used like Raffia palm	Mostly in swamps (around 50%)*	Collected by 23% of HH*	All year	No (7%)*	-	Consumption (100%)*	-	-
Rope	Ngeyei (general term)	*Various species, some listed below*	Various uses for tying, hammocks, equipment, and house construction	Mostly in old bush (around 50%) and community forest (40%).*	Collected by 13% of HH.* Mostly collected by men†	All year	No (9%)*	-	Consumption (100%)*	-	-
	Buwui/ Bowu-gigbo/ gigboi	*Salacia Pyriformis*	Rope used in house construction, but plant also produces sweet edible fruit	Mostly in bush†	Many women see the fruit as important, men less often†	Fruit seasonal	Somewhat†	-	Both, but mostly for consumption†	-	-
	Tormi/ tormei	*Habropetalum dawei*	Rope used in house construction	Mostly in community forest†	Men†	All year	Little†	-	Consumption†	-	-
Camwood/ African sandalwood	Budui/ bundui	*Baphia nitida*	Construction, used to make axe or hoe handle	Mostly in bush and community forest†	Men and women†	All year	Somewhat†	-	Both, but mostly for consumption†	Le 6,000 per pile wood†	-

Medicine											
English	**Mende**	**Scientific name**	**Use**	**Collected where**	**Who collects**	**Collected when**	**Scarcity**	**Processed**	**Consumption or sale**	**Price (adjusted for inflation†) and marketing**	**Notes**
Bush ataya/ bush attire	Nyenijagboi/ genijaboi	*Massularia acuminata*	Bark used as male aphrodisiac, plant also used against pain and to increase blood in system	Mostly community forest*	Men and women, women note that not all households collect it†	All year	Somewhat†	-	Both, but mostly for consumption†	Le 1,000- 1,500 per bundle† In top 9 most frequently traded medicinal products	Sometimes unsustainably harvested
Drumstick tree	Gbangei	*Cassia sieberiana*	Root and bark have various medicinal uses, including treating stomach aches. Most importantly used to treat malaria	Bush and community forest.† Also in GRNP‡	Many men and women find it important.† Typically collected by men‡	All year	Somewhat†	-	Both, but mostly for consumption†	Le 2,000 per bundle. Mostly sold in Kenema market† In top 3 most frequently traded products in Kenema, Bo and Freetown	Sometimes unsustainably harvested
Tree	Kalo-wuli	*Alstonia boonei*	Bark used to treat malaria, skin problems, worms, yellow fever and other ailments. Also can be used to make furniture, extract latex and as firewood	Community forest, bush.† Also in GRNP‡	Men and women†	All year	Little†	-	Consumption†	Le 2,000 per bundle†	Sometimes unsustainably harvested
Plant	Kojo logbo/ kojo wugboi	*Morinda moridoindes*	Used to treat fevers and worms. Also used for pot bellies (kwashiorkor) caused by malnutrition among children	Mostly in bush, also in community forest†	More women find it important than men, but collected quite often†	All year	Somewhat†	-	Consumption†	-	-
Plant	Njasui	*Morinda lucida*	Leaf used to treat malaria and pain. Also used as dye and flavoring food/drinks	Mostly in community forest, also in bush†	More women find important than men, collected quite often†	All year	Little†	-	Both, but mostly consumption†	Le 1,000 per bundle†	Sometimes unsustainably harvested
Tree	Kowei	*Hibiscus sterculiifolius*	Used to encourage the bowel system. Also used as firewood	Mostly in community forest and bush†	Men more often than women†	-	Little†	-	Both, but mostly consumption†	Le 2,000 per cup.†	-

Medicine continued

English	Mende	Scientific name	Use	Collected where	Who collects	Collected when	Scarcity	Processed	Consumption or sale	Price (adjusted for inflation†) and marketing	Notes
Stick	Dovotai	*Smeathmannia pubescens*	Fruit pulp is edible and plant has medicinal uses. Also used as chew sticks for dental hygiene and as firewood	-	Some men collect it†	All year	-	-	-	-	-
Tree	Kpeluwuli	*Annickia polycarpa*	Bark used to treat yellow fever, malaria and liver disorders	-	-	-	-	-	-	-	Sometimes unsustainably harvested
Plant	Fasemi	*Unknown*	Used to treat malaria and fever	2-year-old farm bush‡	Women‡	-	-	-	-	-	-
Camwood/ African sandalwood	Budui/ bundui	*Baphia nitida*	Root and bark harvested to treat malaria, typhoid and fever. Leaves also have medicinal uses. The tree also produces edible seeds	-	-	-	-	Bark dried and sold	-	Le 1,000 per bundle of seeds. Mostly sold in Kenema market†	-
Fruit/ seed	Kifei/ kafei	*Leconodiscus cupanioides*	Used to treat malaria and impotence, also produces sweet edible fruit.	Community forest†	Collected by only 1 HH*	Seasonal	No†	Bark is boiled and drunk	Consumption†	-	-

Other NTFPs

English	Mende	Scientific name	Use	Collect where	Collect who	Collect when	Scarcity	Processed	Consumption or sale	Price (adjusted for inflation†) and marketing	Notes
Bush yam	Ngawui	*Dioscorea spp.*	Hunger food. Ngawui is also preferred as it is sweeter than normal yam	Bush yams mostly collected on farm/plantation (around 40%) and old bush (around 30%).*	Bush yams collected by 57% of HH.* Almost all men and women find important†	Wet season (hungry season)	Somewhat (29%)*	-	Mostly consumption (93%)*	Le 1,000-2,000 a pile/piece. Mostly sold in village, some in weekly market and to traders†	Bylaws state that uprooted vine needs to be buried so that the plant keeps producing. Red river hogs are seen as a pest, as they also eat yams but destroy the plant
	Bobobutei	*Unknown*									
	Mei	*Unknown*									
Mushroom	Falii	*Various species*	Food	Mostly collected in new bush (around 30%) and on farm/plantation (25%)* Also in community forest, however location might depend on the species†	Collected by 16% of HH.* Many more women find it important than men†	Seasonal	Somewhat (34%)*	-	Mostly consumption (98%)*	Le 2,000 a pile†	-
Honey	Kommi	*Various species*	Luxury food which fetches high prices. One account where honey is given to children to encourage their brain development and school performance	Mostly collected in old bush (around 40%) and community forest (around 35%)*	Collected by 12% of HH*. Men collect it†	Hives most productive in dry season, but can be harvest all year	Yes (60%)*	Cut down tree and/or place comb in container, then smoke/burn out beehive	Both (consumption 63%)*	Le 4,000-15,000 per pint. Some sold in village, weekly market and to traders†	High commercial potential. Traditional harvesting method is unsustainable
Fishing poison	Tawei	*Blighia unijugata*	Used to stun fish in dry season so they are easier to catch	Mostly collected on farm/plantation (around 35%) and old bush (around 30%).* 2013 NTFP survey suggests also collected in community forest†	Collected by 3.5% of HH.* Women collect †	Seasonal	Somewhat (21%)*	-	Mostly consumption (96%)*	-	Some communities have stopped using tawei, as it kills fish eggs and also affects the quality of water in streams, sometimes leading to sickness
Firewood	Kowei	*Unknown*	Cooking	Mostly in community forest†	More women than men find kowei important†	All year	No†	Made into charcoal or sold in bundles	Both†	Le 3,000 per bundle. Some is sold to traders†	-

Notes

The tables are compiled using data from the end line REDD survey collected in 2019*, baseline REDD survey collected in 2014**, the NTFP survey from 2013†, a focus group discussion held in Gaura chiefdom in December 2019‡, with additional information provided by Mohammed Swaray the botanist at GRC, academic works by Davies and Richards (1991), Leach (1994), and Jusu and Sanchez (2013), The Useful Tropical Plants Database (2020) and fieldwork undertaken in Sierra Leone between November and December 2019.

Not all percentages in the table taken from the REDD survey* should be taken as representative. Some NTFPs were only mentioned a few times, which is not enough to base their origin or scarcity on, for example. Regarding the classification used in the table, a NTFP was categorized as not scarce if less than 10% of respondents noted the NTFP was scarce or very scarce, little if this was between 10% and 25%, somewhat between 25% and 49%, and scarce if it was over 50%. Regarding consumption or sale, if over 75% of respondent noted that an NTFP was mainly for consumption, the NTFP was listed as 'mostly consumption', otherwise listed as 'both'. The category 'both' includes respondents that answered a NTFP is mainly for sale or both for sale and consumption. The share of respondents that answered 'consumption' is listed, so a low value for this indicates higher shares of people choosing 'sale' or 'both'. Information on who collects NTFPs was partially taken from the 2013 NTFP survey†. Moreover, price information was gathered from this survey. The prices are adjusted for inflation between 2013 and 2019. Therefore, the average price per unit listed is a rough estimate, as prices might have changed over these years. Other prices listed come from fieldwork findings.

Appendix III – NTFP collection by chiefdom

Table x: NTFP collection and sales by chiefdom (%)

	Collection	Sale
Barri	77.6	22.9
	(83)	(19)
Gaura	80.5	24.9
	(207)	(51)
Koya	87.7	28.0
	(50)	(14)
Makpele	88.6	50.0
	(93)	(46)
Malema	92.6	32.0
	(125)	(40)
Nomo	94.3	24.0
	(50)	(12)
Tunkia	85.8	25.7
	(109)	(28)
Total	85.3	29.4
	(711)	(210)

Notes: frequency in brackets. Source: REDD data 2019.

Appendix IV – Correlation NTFP sales and transport cost

VARIABLES	NTFP Collection (=1)
Low yields (=1)	-0.0899
	(0.0649)
Food shock (=1)	0.0443
	(0.0477)
Death shock (=1)	0.00717
	(0.0625)
Health shock (=1)	0.0342
	(0.0445)
Transport cost to market	**-0.00417*** **
	(0.00116)
Age household head	0.000128
	(0.00145)
Household size	-0.00501
	(0.00613)
Dependency ratio	0.0376**
	(0.0181)
Female (=1)	-0.0692*
	(0.0381)
Leader or respected person (=1)	-0.0643
	(0.0461)
Stranger (=1)	-0.0361
	(0.0489)
Constant	0.358**
	(0.114)
N	710
R-squared	0.070
Chiefdom fixed effects	YES

Notes: Standard errors in parentheses. Dependent variable is binary, with at least one NTFP collected in 2018 equal to 1, 0 otherwise. *** p<0.001, ** p<0.05, * p<0.1. Source: REDD data 201

Appendix V – Photos taken during fieldwork

Source of all photos is the author.

1. Animal trap

Notes: (Inactive) trap in a fence separating the community forest and farms/plantations.

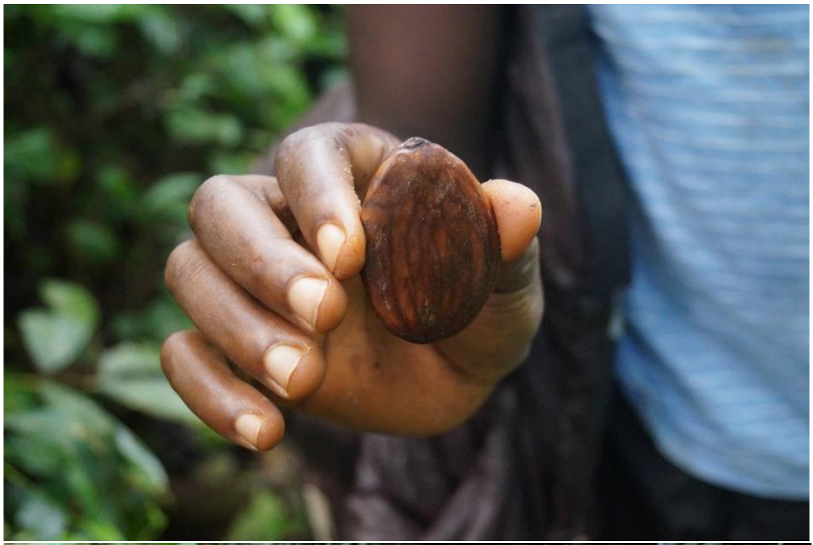
2. Fish trap

3. Helei

4. Sagbei (bitter kola)

Notes: On the left and top right, the bitter kola fruit. Inside there are several nuts which can be dried (lower right).

5. Fawei



Notes: seed is pictured above, the pod below.

6. Dawei

7. Hewei

Notes: When the pod ripens it breaks open and distributes its seeds.

8. Rattan bundle

9. Bamboo (on left) near river

10. Rattan products

Notes: From left to right, rattan basket, chair, and fish drying rack.

11. Thatch

Notes: Above a picture of a school with thatched roof. On the ground are bundles of thatch, which will be used to fill gaps in the roof. Also note that bamboo is used for the construction of the walls of the school. Below is a craftsman weaving thatch roof parts.

12. Thatch tree and product

Notes: Rope is woven from *raffia palm* (picture above) and used to make products such as hammocks (picture below).

13. Building poles

14. Edible mushroom

15. Tawei

Notes: Pictured above is ripe tawei. The inside is harvested and used to make fishing poison, as seen in the lower picture.