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Central Africa Humid Tropics Transect Sentinel Landscape (CAFHUT)

A stocktaking pilot study

Revised Edition, May 2021

Denis J. Sonwa, Frederick Nkeumoe Numbisi, Duplex Noumbissi, François Essouma Manga, Patrice Levang, Bertin Takoutsing, Albert Le Grand Fosso, Laurent Vidal, Brian Chiputwa, Divine Foundjem-Tita, Frankline Nghobuoche, Serge Mandiefe Piabuo and Peter A. Minang

RESEARCH PROGRAM ON Forests, Trees and Agroforestry

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Errata:
- Page 4: Figure 1, map updated
- Page 6: Ayos description, 1st paragraph updated

CGIAR Research Program on Forests, Trees and Agroforestry
CIFOR Headquarters
Jalan CIFOR
Situ Gede, Sindang Barang
Bogor Barat 16115
Indonesia

T +62-251-8622-622
E cgiarforestsandtrees@cgiar.org

foreststreesagroforestry.org

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List of acronyms

ADNG	Association communautaire pour le développement de Ngoume
ADR	Age Dependency Ratio
AFS	Cocoa agroforestry systems
AFS4FOOD	Agroforestry for Food Security
AFTPs	Agroforestry Tree Products
AGC	Aboveground Carbon
ASB	Alternatives to Slash-and-Burn
CAFHUT	Central African Humid Tropics
CFEs	Community Forest Enterprises
CIFOR	Center for International Forestry Research
CIRAD	French Agricultural Research Centre for International Development
CODEM	Communauté de développement du village Messok-Messok
CoForSet	Congo Basin Forests – Biodiversity Offsetting Mechanisms
CoForTips	Congo Basin Forests – Tipping Points for Biodiversity Conservation and Resilience of Forested Socioecological Systems
CGIAR	Consortium of International Agricultural Research Centers
DRYAD	Financing sustainable community forest enterprises in Cameroon
EPHTA	Ecoregional Programme for the Humid and Subhumid Tropics of Subsaharan Africa.
F-cAFS	Forest-derived cocoa agroforestry systems
FCS	Food Consumption Score
FTA	Forests, Trees and Agroforestry
GDP	Gross Domestic Product
HDDS	Household Dietary Diversity Score
HFIAS	Household Food Insecurity Access Scale
ICRAF	World Agroforestry
IFRI	International Forestry Resources and Institutions
IRD	French National Research Institute for Sustainable Development
IUCN	International Union for Conservation of Nature
LDSF	Land Degradation Surveillance Framework
MIR	Mid-infrared
NTFPs	Non-Timber Forest Products
ProCISA	Pro-Intense Africa Project
REALU	Reducing Emissions from All Land Uses
REDD+	Reducing Emissions from Deforestation and forest Degradation
SAFSE	Search for trade-offs between production and other ecosystem services provided by tropical agroforestry systems
S-cAFS	Savanna-derived cocoa agroforestry systems
SDI	Soil Degradation Index
SL	Sentinel Landscapes
SLOs	System level outcomes
SOC	Soil organic carbon
SoCa	Beyond climate, Soil Carbon sequestration to sustain tropical family farming
STRADIV	System approach for the transition to biodiversified agrosystems
TLU	Tropical Livestock Unit
WWF	World Wide Fund for Nature

Executive summary

The Sentinel Landscapes (SL) initiative is comprised of geographic areas or sets of areas with a broad range of biophysical, social, economic and political conditions. This report takes stock of the work carried out on the Central Africa Humid Tropics Transect Sentinel Landscape (CAFHUT) within the context of the CGIAR Research Program on Forests, Trees and Agroforestry (FTA). It reports on core SL work and draws from the broader project activities of multiple partners within the FTA research program. The FTA research consortium mainly consisted of Bioversity International, the Center for International Forestry Research (CIFOR), the French Agricultural Research Centre for International Development (CIRAD) and World Agroforestry (ICRAF), collaborating with the French National Research Institute for Sustainable. The CAFHUT study sought to address the following: to better understand the drivers behind deforestation/forest degradation; to create the capacity and best methods to meet development needs; to gauge the ecological and genetic impact on forests from land-cover and land-use changes; and to support the promotion and implementation of sustainable multiple-use forest models as a result of these efforts.

The sentinel landscape covers sites where the pressures of urban development, population growth, forest commercialization and land-use transition are changing the forest landscape at a rapid pace. Four study sites in Cameroon were chosen: (a) Mintom – a transition zone between mature old growth forest and logged-over forest, with a mixture of active forest concessions, recently allocated community forests and unallocated forest concessions; (b) Lomie-Kongo – an area composed of degraded mature forests, where concession, community forestry and timber exploitation are influencing the forest structure; (c) Ayos – situated 123 km from Yaoundé, the capital of Cameroon. Ayos vegetation is characterized by gallery forests surrounded by swamp forests of raffia; and (d) Bokito – a forest-savanna or deforested landscape, situated some 150 km from Yaoundé, where secondary forest is used to grow cash and subsistence agricultural and agroforestry crops.

The CAFHUT core work concentrated on land and soil analysis as well as socioeconomic analysis and mapping. The study of land health used the Land Degradation Surveillance Framework (LDSF) as the principal field-data collection tool in the four selected sites. A total of 640 plots, 1280 soil samples and 96 infiltrations were used for analysis. All the collected samples were processed and subsamples were shipped to the Soil-Plant Spectral Diagnostics Laboratory at ICRAF in Nairobi, Kenya. Soil samples were analyzed using mid-infrared (MIR) methods. Socioeconomic information was collected through primary and secondary sources. Primary data were collected in all four sites covering 38 villages and 927 households, while secondary data were based on analysis of theses, dissertations and scientific articles. Within the socioeconomic work, some institutional and natural resource governance activities were carried out. The detailed institutional mapping exercise that was to be implemented using the International Forestry Resources and Institutions (IFRI) protocols – Forms A, R, F and S – and the Natural Resources Governance Framework never took place due to a lack of resources.

In broader terms, three main areas of work can be highlighted with the following aims: to reduce deforestation and forest degradation; to improve cocoa agroforestry and cocoa landscapes; and to alleviate poverty. These are the key land-management issues in the CAFHUT landscapes. Following a review of projects and research in these three areas over the past 10 years, we provide an overview of the work carried out.

Reducing deforestation and forest degradation: With an increasing human population and demand for food, pressure on the forest has increased along the sentinel landscape. Three projects aimed to reduce emissions from all land use, to exploit opportunities for avoided deforestation with sustainable benefits, and to identify points for biodiversity conservation and the resilience of forested social and ecological systems. With the help of satellite images, it was predicted that deforested areas in Mindourou and Guéfigué will increase twofold over the period 2020–2030 compared with the period 2000–2010. The results equally highlight that cassava, groundnuts and maize are the main crops responsible for cropland expansion, while the area dedicated to the cultivation of palm oil is also expected to double from 2010 to 2030. Land-cover maps for Akok and Awae show different patterns of land-use evolution between the two villages. Forest land in Akok decreased from 26% to 18%, while secondary forest increased from 57% to 67%. Awae experienced a reduction of forest land from 14% to 7%, while secondary forest remained relatively stable; however, short-duration fallow increased from 22% to 34%. A feasibility assessment of emissions reductions in Efoulan municipality was conducted from 2001 to 2007, showing a considerable decline in undisturbed forest, amounting to 194 ha/year mainly due to cocoa plantations (145 ha/year) and crop fields (45 ha/year). Logged forests decreased by 63 ha/year due to land degradation, thus weakening the landscape's carbon stock potential.

An analysis shows that various drivers are responsible for the deforestation and land degradation of the CAFHUT landscape. Land conversion by small-scale subsistence farmers and market-based agriculture; conversion for commercial plantations (oil palm, banana, rubber, pineapple); mining; infrastructure development; and all types of logging schemes (industrial, artisanal, legal and illegal) are the principal drivers of deforestation. There remain challenges relating to technology in mapping land-use changes and to legal definitions of forest. For emission-reduction strategies to be efficient, cross-sector collaboration by all stakeholders is required. For instance stakeholders in the cocoa sector, intensifying cocoa agroforestry systems have the potential to store about 180 tons of carbon per hectare; a reason enough to promote agroforestry, especially if coupled with tree planting on farms for timber and food.

Cocoa agroforestry systems and landscapes improvement: Just like in any forest area within the Congo Basin, cocoa agroforestry is one of the dominant land uses along the sentinel landscape, contributing to the livelihoods of millions of farmers. Cocoa is the main farming activity, representing 89% of cultivated areas and 59% of agricultural income for households in the village of Talba. Project interventions along this landscape aimed to resolve problems relating to diversification and intensification; soil characteristics; cocoa yield; botanical composition and vegetation structure; pests and diseases as well as contribution to household income. A total of six projects developed various interventions aimed at improving cocoa agroforestry in terms of yield and farmer incomes, while reducing forest clearance for agriculture. For example, results revealed that a total of 6677 cocoa plants were produced in Lobeke and the plants from the communities' nurseries were used to establish small cocoa plots of 2.5 ha. In 2015, a total of 2760 trees were integrated into cocoa agroforestry systems in Efoulan, while 85% of cocoa farmers in this area were engaged in the intensification of cocoa agroforestry systems through tree planting. An evaluation of potential yield in Bokito showed that the average number of pods per tree is 17.3 and the average weight of pods is 497.4 g (0.497 kg). In Bokito, the average density of cocoa population is 1222 plants per hectare and yields increase significantly with age. On average, irrespective of age, potential yields were higher on plots created on savanna-preceding (866.9 kg/ha) than those created on forest-preceding vegetation (786.6 kg/ha), but the yields were not significantly different. Diseases are responsible for 17% of losses, while 2% is lost to rodents. It is observed that the destruction caused by mirids[1] increases with the age of the farm.

Although interventions along this landscape aimed at improving the quality and quantity of cocoa while boosting farmers' incomes, pest management remains a major problem for farmers. Issues relating to post-harvest management and the entrepreneurial aspects of cocoa agroforestry were not sufficiently examined by the various projects. Thus, for farmers to fully benefit from cocoa agroforestry systems, using a holistic approach that includes the business dimension will provide additional motivation for farmers to take up new concepts as significant employment and income will be generated.

Poverty reduction: Although a major goal of most project interventions in the SL is to address poverty, some were specifically designed to diversify and stabilize the incomes of poor small-scale farmers by increasing their participation in – and benefits from – the value chains of agroforestry tree products (AFTPs). From a value chain perspective, we learned from projects carried out in the landscape that vegetative propagation and on-farm cultivation of non-timber forest products (NTFPs) can effectively contribute to sustained quality production and therefore, play an important role in improving value chains. However, many producers still collect trees/vines that grow spontaneously (especially for njansang, *Irvingia* and *Gnetum*) without any germplasm improvement and/or management. From such projects, it became evident that for farmers to reap the full benefits and increased revenue from most NTFPs more attention was needed to conservation, processing and packaging issues. In this regard, experience from such projects suggests that more development projects are needed on value chains to explore processing opportunities. However, this would require teaming up with more specialized institutions and, if possible, the private sector.

Some projects tested organizational arrangements by which NTFP producers can link up more efficiently with traders and the private sector. The ultimate objective was to improve the integration of low-income farmers in NTFP value chains. Results show that it is important to increase the capacity of producers and traders, so that they can engage in collective action and connect with each other. It is also vital to develop financial mechanisms in order to overcome some of the barriers that producers and traders face when they try to increase their participation in value chains. Some of the projects concluded that much work still needs to be done to develop NTFP markets and products. It is also necessary to help farmers and traders to develop sustainable enterprises around NTFPs.

Results from the projects show positive effects of collective action on farmer livelihoods. However, some of the research also raised questions that would need more in-depth social and anthropological research in order to fully understand producers' behavior and to facilitate the scaling of the approach beyond project sites.

1 The term mirid or miridae refers to a large and diverse insect family also known by the taxonomic synonym *Capsidae*. Common names include plant bugs, leaf bugs, and grass bugs. See also: http://research.amnh.org/pbi/

1 Introduction

The Sentinel Landscapes (SL) initiative is comprised of geographic areas or sets of areas with a broad range of biophysical, social, economic and political conditions. It is part of the CGIAR Research Program on Forests, Trees and Agroforestry (FTA), which was established in 2011 to conduct long-term research, using standardized methodologies, on the temporal and spatial dynamics of trees and forests in selected sites. The Central African Humid Tropics (CAFHUT) sentinel landscape covers sites where the pressures of urban development, population growth, forest commercialization and land-use transition are changing the forest landscape at a rapid pace. Four study sites in Cameroon were chosen: (a) Mintom – a transition zone between mature old growth forest and logged-over forest, with a mixture of active forest concessions, recently allocated community forests and unallocated forest concessions; (b) Lomie-Kongo – an area composed of degraded mature forests, where concession and community forestry and timber exploitation are influencing the forest structure; (c) Ayos – situated 123 km from Yaoundé, the capital of Cameroon. Ayos vegetation is characterized by gallery forests surrounded by swamp forests of raffia; and (d) Bokito – a forest-savanna or deforested landscape, where secondary forest is used to grow cash and subsistence crops by agricultural and agroforestry means.

The CAFHUT project aimed to collect socioeconomic, institutional and biophysical information to assess the relationship between livelihoods and land health in forested landscapes that have been exposed to various forms of land-use change. Due to limited funding, field research in CAFHUT was limited to two areas: (a) land and soil analysis, and (b) socioeconomic analysis and mapping. The study of land health used the Land Degradation Surveillance Framework (LDSF) as the principal field-data collection tool in the four selected sites. A total of 640 plots, 1280 soil samples and 96 infiltrations were used for analysis. All the collected samples were processed and subsamples were shipped to the Soil-Plant Spectral Diagnostics Laboratory at the World Agroforestry (ICRAF) in Nairobi, Kenya. Soil samples were analyzed using mid-infrared (MIR) methods. Socioeconomic information was collected through primary and secondary sources. Primary data were collected in all four sites covering 38 villages and 927 households, while secondary data were based on analysis of theses, dissertations and scientific articles. Within the socioeconomic work, some institutional and natural resource governance activities were carried out. The detailed institutional mapping exercise that was to be implemented using the International Forestry Resources and Institutions (IFRI) protocols – Forms A, R, F and S – and the Natural Resources Governance Framework never took place due to lack of resources.

This report takes stock of the work carried out in the CAFHUT Sentinel Landscape within the context of the CGIAR Research Program on Forests, Trees and Agroforestry. It reports on core SL work and draws from the broader project activities of multiple partners within the FTA research program. The FTA research consortium mainly consisted of Bioversity International, the Center for International Forestry Research (CIFOR), the French

Agricultural Research Centre for International Development (CIRAD) and World Agroforestry (ICRAF). The CAFHUT study sought to address the following: to better understand the drivers behind deforestation/forest degradation; to develop the capacity and best methods to meet development needs; to gauge the ecological and genetic impact on forests from land-cover and land-use change; and to support the promotion and implementation of sustainable multiple-use forest models as a result of these efforts.

The rest of the report is structured as follows: Section 1 explains how the sites were selected and provides an overview of the four sites that were finally retained. A description of the socioeconomic and biophysical data on land degradation is presented in this section, together with the sampling plans for both studies. Section 2 is a systematic analysis of research activities that different development partners have conducted in the landscape over the past 10 years. The section is divided into two subsections: Subsection 2.1 summarizes the findings under three themes characterizing major development challenges/opportunities in the landscape, including deforestation; cocoa intensification and diversification; and poverty reduction. Subsection 2.2 links the various research projects to the four themes planned in 2012, including socioeconomic, institutional, biophysical and land health. Section 3 covers a preliminary analysis of the socioeconomic data collected within the CAFHUT. The results are divided into household assets and ownership, household farm dependency, income diversity, poverty, as well as household welfare, food security and nutrition. Section 4 highlights the partners involved and makes an inventory of different stakeholders who have worked in the landscape. Section 5 underscores the lessons learned, as well as major challenges and recommendations from projects executed within the landscape.

2 Brief history of how the specific sentinel landscape was built and how work was conducted in practice (different steps, processes)

The Sentinel Landscapes project is the result of consultations that took place in the CAFHUT region during the development (and/or the early implementation phase) of FTA. It also relies on the willingness of participants to provide a set of transects for medium- to long-term research that can inform decision makers. The region has hosted benchmark studies through the Alternatives to Slash-and-Burn (ASB) program and EPHTA (Ecoregional Programme for the Humid and Subhumid Tropics of Subsaharan Africa), providing a set of transects that represented the Congo Basin and the humid forest zone of West and Central Africa, respectively. The overarching idea behind the SL was to utilize the multidisciplinary and diverse experience of the institutions in order to generate information that can open up transformational pathways. This should be done while making reference to the System Level Outcomes (SLO) of CGIAR, including (i) to reduce poverty; (ii) to improve health, food security and nutrition; and (iii) to enhance environmental sustainability and ecosystem services. The idea was therefore to have new sites, and then to conduct a baseline assessment of the status quo along the SL.

The Congo Basin is considered a barometer of ecological and socioeconomic conditions in forest landscapes on the African continent. Since the Congo Basin provides several ecological services (i.e. biodiversity conservation and climate-change mitigation) and products, the threats to its environmental health are an issue for the international community. Unfortunately, some factors that contributed to low deforestation in the past are changing and will continue to do so with globalization. Therefore, based on their experience in the Congo Basin and with the help of their regional/worldwide networks, the CAFHUT research centers collaborated to address the following: (i) to better understand the drivers behind deforestation/forest degradation; (ii) to create the capacity and best methods to meet development needs; (iii) to gauge the ecological and genetic impact on forests from land-cover and land-use changes; and (iv) to support the promotion and implementation of sustainable multiple-use forest models.

Sites were selected based on their representativeness of the humid forest landscapes in Central Africa, while taking advantage of some existing activities within the sites. The CAFHUT represents a dynamic socioecological gradient of forest and land use in the Congo Basin. Currently focused on Cameroon, the project chose sites that demonstrate a gradient where forest and tree-based livelihoods are – and will be – prevalent means of poverty alleviation. These sites are also affected by the pressures of urban development, population growth, the commercialization of forest products and land-use transition. These factors are changing the forest landscape at a rapid pace. In particular, the landscape features are:

1. Mature humid dense forest in the southeast of the country, where forest-dwelling men and women profit from hunting as well as the consumption and sale of non-timber forest products.

2. Fragmented mosaics of primary and secondary forests impacted by (a) an extensive yet poorly understood informal timber market, (b) a 100-year-old logging industry that accounts for 6 percent (on average) of the gross domestic product (GDP) of many Central African countries, and (c) vast roads paving the way to logging and mining concessions in the heart of the Congo Basin.
3. Peri-urban areas where both primary and secondary forest fragments still exist, but where the land use has been dominated by mixed smallholder agroforestry and intensified agricultural systems.
4. Zones where forest meets savanna and agricultural activities dominate, but where local inhabitants have begun to reap the rewards of cocoa agroforestry, slowly transforming deforested landscapes into productive and profitable tree-based livelihoods (Figure 1).

2.1 Site selection

The CAFHUT site was selected by a consortium of Bioversity International, CIFOR, ICRAF and CIRAD. This followed two larger workshops in 2012, designed to identify partners and sites within which the work would be done. The selection process downsized from 15–10 sites of 10 x 10 km^2 to a shortlist of eight sites that were later visited by a team of researchers from Bioversity International, CIFOR and ICRAF. Four sites – Bokito, Ayos, Mintom and Lomie/Kongo – were finally chosen by a committee after field visits (Figure 1). The sites discarded were Bafia, Obala and Bikok and the site in the Dja reserve was indicated as a nonactive research site that should represent the 'mature growth forest.' The four sentinel sites thus represented a gradient of intensive agriculture, pasture, agroforests and forests.

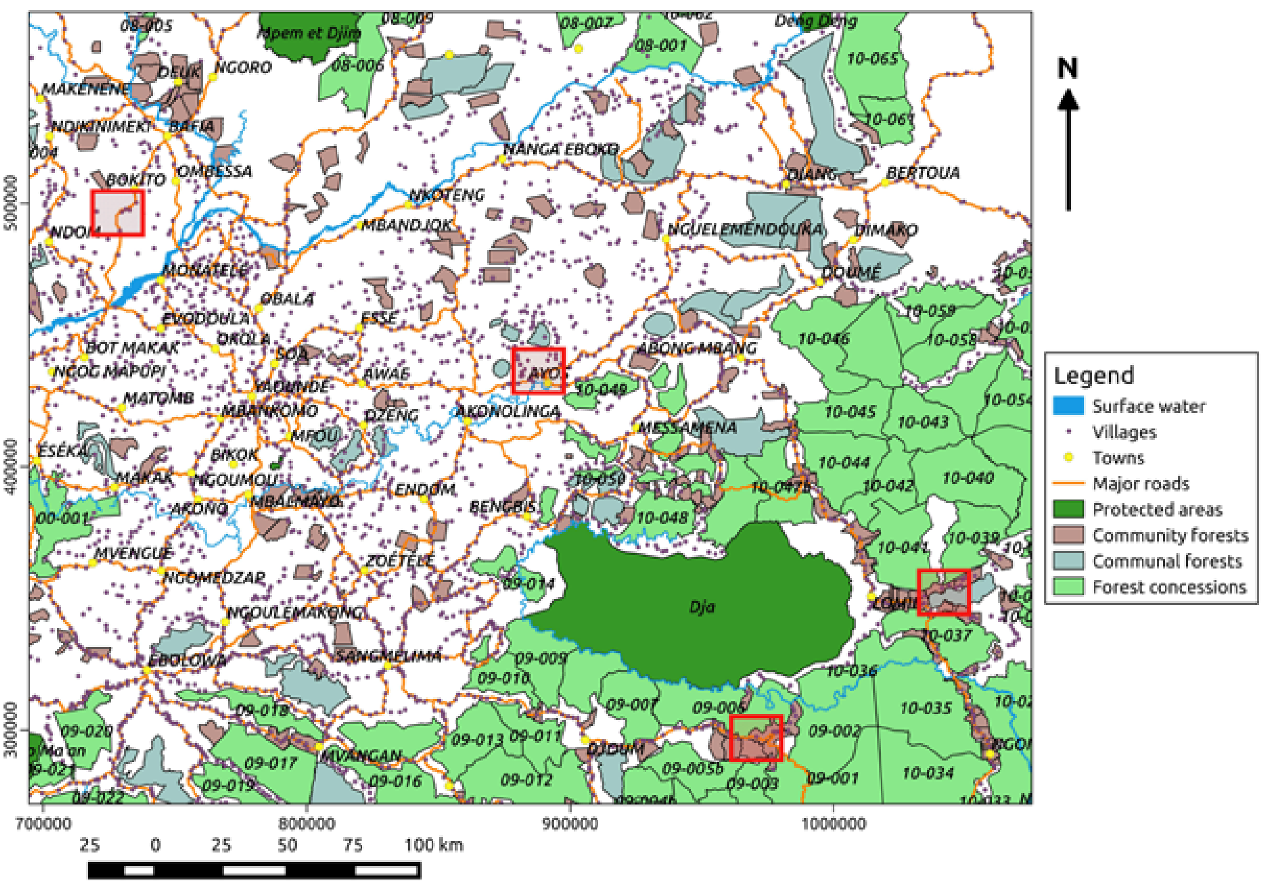

Figure 1. Sentinel sites identified in the Central Africa Humid Tropics Transect

Source: Cameroon sentinel landscape team, Data: WRI Interactive forestry atlas of Cameroon 2013

Note: SL sites indicated in red rectangles.

2.1.1 Brief presentation of the four selected sites and key research questions

Figure 2 below presents the position of each site along the forest transition curve.

Mintom: Located in southern Cameroon between latitude 2°30' and 2°45' N and longitude 13°15' and 13°30' E, within a humid equatorial climatic zone. The southern part of Cameroon is a vast area stretching from the Atlantic Coast in the West to the Congo Basin in the east. This area features plateaus with a lower altitude of 620m and is inhabited by more than 10,000 people across 60 villages. Most belong to the Fang, Djem, Nzimé, and Baka ethnic groups. The Ngoyla-Mintom forest block is found in this region and covers 932,142 hectares – the largest expanse of undisturbed tropical rainforest in Cameroon. In this landscape, this site represents the transition between mature old-growth forest and logged-over forest, with a mixture of active forest concessions, recently allocated community forests, and unallocated forest concessions. Currently, the site hosts both production and virgin primary forest as well as an important wildlife corridor, but a vast road is being opened through this area, meaning that radical changes have been observed in a period of just a few years. Markets have opened and smallholder/community activities have intensified, including agriculture and agroforestry, hunting, informal logging, and commercial activities.

Lomie-Kongo: Located in the Upper Nyong division of Cameroon's Eastern Province between latitude 03°09' N and longitude 013°37' E with an altitude of 624 m. It is characterized by a wet equatorial climate (also known as a Guinea-type climate) and high temperatures (24°C on average). There is a long dry season from December to May, a light wet season from May to June, a short dry season from July to October, and a heavy wet season from October to November. Humidity and cloud cover are relatively high, and annual precipitation averages 1500–2000 mm. Lomie-Kongo is sparsely populated with fewer than five persons per km^2. This is mostly due to the area's thick forests, which inhibit settlement and support disease-carrying insects. The vast majority of the region's inhabitants are subsistence farmers. Major crops are plantains, maize, groundnuts, cocoyams, cassava, pineapples, oranges, mangoes and yams. The dense forest and the presence of the tsetse fly prevent much cattle raising, but various livestock are raised for subsistence purposes. Lomie-Kongo represents degraded mature forest, where concession and community forestry and timber exploitation are some of the principal activities influencing the area's forest structure. Other forest-related activities include hunting and the collection of some non-timber forest products. Agriculture and agroforestry practices exist, but they have not been intensified because access to markets is more difficult here.

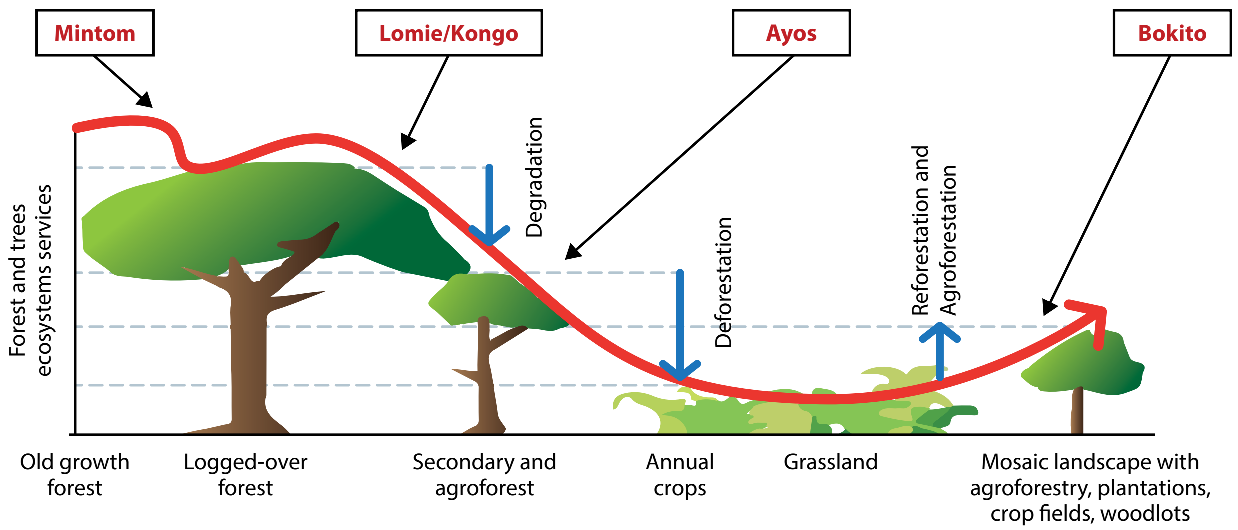

Figure 2. Position of the four sites along the forest transition curve

Ayos: The municipality of Ayos is situated 123 km from Yaoundé, the capital of Cameroon. Ayos vegetation is characterized by gallery forests surrounded by swamp forests of raffia and cocoa-production systems of much lower intensity. Ayos has a surface area of 1250 km^2 with an estimated population of 22,899 inhabitants. The entire population of this municipality depends directly on subsistence farming for their livelihoods, with cocoa among the main agricultural produce. The zone falls within the forest margin landscape where agriculture and agroforestry products are the mainstay for much of the population, and agricultural practices are relatively mature (mostly cocoa, coffee, oil palm). The area is inhabited by growing rural communities with access to markets and comprises about 39 villages under two main groups – Yebekolo-Est and Omvang. Its geographical position provides an avenue for the flow of money, which is reflected by progressive investments in activities such as fishing, hunting and small-scale plantations (cocoa, oil palm, pineapple), supplying local and neighboring markets in Abong Mbang to the east and from Awae to Yaoundé in the west.

There is a high presence of elite population and investments in the area, and a well-established road network that has provided access to large markets. The site is inhabited by growing rural communities with access to markets and comprises about 39 villages under two mains ethnic groups – Yebekolo and Omvang. Its geographical position provides avenue for economic activities as is reflected in the progressive investments in activities such as fishing, hunting, small scale plantations (cocoa, oil palm, pineapple, etc.), which supply local and neighbouring markets in Abong Mbang to the East and from Awae towards Yaoundé in the West. Its vegetation is characterised by gallery forests surrounded by swamp forests of raffia. Most municipalities depend directly on subsistence farming for their livelihoods with cocoa being one of the principal agricultural produce. Thus, agriculture and agroforestry products are the mainstay for a large proportion of the population, and agricultural practices are relatively mature (mostly cocoa, coffee, oil palm). The swamp forests of the upper part of Nyong river tributaries form a sort network of peatlands - the Ayos-Abong-Mbang peatlands (Bernard et al. 2013). This is said to be a perculiar ecological milieu, especially in terms of biodiversity and carbon storage in terrestrial peatlands. The presence of ICRAF, through ASB research experience, is an assurance for available information about the dynamics in the area.

Bokito: Located between 4°35' N and 11°8' E in the Center Province of Cameroon in the Mbam-et-Inoubou district. It consists of more than 10 villages: Assala, Bakoa, Begny, Bokaga, Bongando, Okolé, Kedia, Ossimb I, Ossimb II, Tchekos, Yorro, Tobagne and Omeng. The Yambassa is the primary ethnic group. Other groups include Lemandé (Tchekos) and Mma'ala (Omende,Yangben). Bokito has an equatorial transition-type climate with bimodal rainfall, characterized by two rainy seasons and two dry seasons with variable durations. The average temperature is 26.8°C and the average annual rainfall is between 1200mm and 1450mm. The main dry season lasts 5 months (mid-November to mid-April). Bokito is located in the forest-savanna transition zone, where there is a low population density (29 inhabitants per km^2), characterized by a patchwork of forest galleries along with herbaceous and sedge savannas on rejuvenated, slightly desaturated soils. Cultivation of cocoa is exclusively carried out by the autochthones of the Yambassa ethnic group. Bokito represents the forest-savanna or deforested landscape dynamic, where secondary forest is used for growing cash and subsistence agricultural and agroforestry crops. All forest land has been allocated, so some farmers have begun to successfully grow cocoa and oil palm in the savanna. The site shows deforested landscapes, forest-savanna mosaics and successful reforestation efforts. There is good access by road, and a long-term CIRAD presence, ensuring links to local smallholders and some past data.

The four sites in southern Cameroon were selected because they represented different stages of the forest transition curve. This project aimed to collect a set of standardized variables, both socioeconomic and biophysical, in order to assess the relationship between livelihoods and land health in forested landscapes that have been exposed to various forms of land-use change. The data will be used to conduct a comparative study on the following research questions:

- What are the institutional settings that favor the utilization of forest resources in ways that result in more equitable sharing of benefits?
- What are the factors that induce people to value the ecosystem services of trees and to manage the landscape for this purpose?
- What are the conditions that allow farmers to significantly capitalize on tree products and to benefit from them?

2.2 Description and collection of data

2.2.1 Socioeconomic

Village selection and household surveys

Village selection
For the socioeconomic study, the selection of villages for each sentinel site was based on:
- accessibility of the villages (cost of logistics);
- total number of villages within and around the sentinel site;
- total population within and around the sentinel site.

Whenever possible, a minimum of 10 villages were randomly selected for each sentinel site.

Villages were located within a 30 x 30 km^2 radius based on the center of the LDSF site. A minimum of five villages were chosen within the core sentinel site (10 x 10 km^2) to ensure that we have a collocation of both biophysical and socioeconomic samples.

Villages were stratified based on:
- distance to main road (distance from market)
- ethnic groups (migratory vs. resident villages)
- distance from forest edge

Household surveys
For the household surveys, a representative sample was randomly selected from each of the villages taking part in the survey. This sample covered about 25–30% of all households. To randomize samples, we used a list of households from the national census. Acknowledging that men and women have different roles and viewpoints in a household and in the community, we tried to ensure an equal representation of female and male respondents. Ultimately, 38 villages were chosen and 927 households were surveyed (Table 1).

Research design and tools

Data source and tools used for collection
Two sources of information were used in this study: primary and secondary.

Secondary sources
Secondary sources helped us to obtain and mobilize existing data through documentary analysis (theses, dissertations, research articles) available in CIFOR's library, online and at the stakeholder level.

Primary sources
Primary sources permitted us to gather new data sets. This data collection was carried out through focus group discussions and household surveys.

Focus group discussions
Focus groups helped us to collect information at the village level. This included data on:
- demographics
- formal and informal institutions
- use, access, governance and management of trees and tree products
- access to markets and structure of the markets
- collective action
- social mobility within the village

The following IFRI instruments[2] were used in focus group discussions:

a. Form F: The Forest Form defines a forest as a surface area of at least 0.5 ha that has woody vegetation, is exploited by at least three households, and is governed overall by the same legal structure. This form was aimed at collecting data on the forest area's size, ownership, vegetation, forest products harvested, and their uses. Changes in the density of trees, grassland or ground cover, as well as changes in forest area, were also captured.[3]

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2 For an extensive review of the IFRI methodology and instruments, refer to the IFRI manual here: http://ifri.forgov.org/wp-content/uploads/2012/09/IFRI_Manual.pdf

3 http://www1.cifor.org/fileadmin/subsites/sentinel-landscapes/document/Forest_Form.pdf

Table 1. Villages selected and number of household surveys per site

Site	Villages		Households	
	Number of villages per site	Name	Number of households per site	Total
Ayos	10	Abeng-Nnam	29	271
		Bifos	24	
		Mbang	29	
		Mekouma	11	
		Ndelle	34	
		Ngoumesseng	33	
		Niamvoudou	33	
		Nkolmveng	15	
		Nsan_II	28	
		Yebe	35	
Bokito	10	Bakoa	33	323
		Batanga	31	
		Bongando	30	
		Bougnoungoulouk	29	
		Kedia	30	
		Ossimb	33	
		Tchekos	35	
		Tobagne	30	
		Yangben	39	
		Yoro	33	
Lomie-Kongo	9	Achip_2	17	199
		Doumzok_2	10	
		Eschiambor	33	
		Kongo	32	
		Mayang	27	
		Melene	9	
		Moanguele_Bosquet	29	
		Nemeyong_III	9	
		Ngola	33	
Mintom	9	Akom	30	134
		Assok	7	
		Belle-ville	4	
		Bite	6	
		Ekombite	20	
		Lele	28	
		Mboutoukong	16	
		Nkolfong	15	
		Nkolkoumou	8	
Total	**38**			**927**

b. Form S: The Settlement Form identifies a settlement inhabited by one or more communities and elicits demographic information about the settlement and its relation to external markets and administrative centers. The form also collects information on climatic features, soil types, vegetation, topography and elevation of the settlement and surrounding area.[4]

4 http://www1.cifor.org/fileadmin/subsites/sentinel-landscapes/document/SL_Settlement_Form.pdf

c. Form A: The Forest Association Form is designed to obtain information relating to one or more forests through the activities of forest users.[5]
d. Form R: The Forest Product Form collects data on consumptive and non-consumptive uses of forest products by a households in a settlement.[6]

Household surveys
The Sentinel Landscape Household Module[7] was used to collect information at the household level.

2.2.2 Biophysical assessment and Land Degradation Surveillance Framework (LDSF)

Experimental design

Four sentinel sites that are statistically representative of the variability in climate, topography and vegetation of the sentinel landscape area were established, as shown in Figure 1. The sites were characterized using the LDSF as the field data collection tool. The LDSF is a spatially stratified, random sampling design framework built around the concept of sentinel site (Vågen et al. 2010; Vågen et al. 2013; Winowiecki et al. 2016). A sentinel site is a demarcated landscape of 100 km^2 that is representative of a larger area of landscape. Each sentinel site was further subdivided into 16 grids of 2.5 x 2.5 km within which 10 sampling plots were randomly allocated, resulting in 160 plots per site. Each plot has an area of 1000 m^2 and consists of four subplots of 100 m^2 each. The coordinates of the plots were loaded onto a handheld Global Positioning System (GPS), which was used to navigate to each of the 160 sample plots that make up the site.

The framework allows the assessment of several ecological metrics simultaneously at four different scales (100 m^2, 1000 m^2, 1 km^2, 100 km^2), using a spatially stratified, hierarchical sampling design (Vågen et al. 2013; Vågen et al. 2016). The framework is useful in monitoring changes over time and providing opportunities for targeting improved soil management and land restoration activities (Winowiecki et al. 2018).

Field data collection

Observations and measurements were made at the plot (1000 m^2 circular plots) and subplot levels (100 m^2 circular plots) following procedures described in Winowiecki et al. (2018). The following data were recorded at each plot (n = 160 per site): observations of slope (in degrees); vegetation structure using the FAO Land Cover Classification System (forest, woodland, bushland, shrubland, wooded grassland, grassland, or cropland); topographic position (upland, ridge/crest, mid-slope, foot-slope or valley); land management; and land-use history.

Visible observations and classification of soil erosion prevalence were made within each circular subplot (n = 4 per plot, 640 per site), such as gully erosion, rill erosion, sheet erosion or none. Vegetation was measured at the subplot level, and woody and herbaceous covers were rated as: <4%; 4–15%; 15–40%; 40–65% and >65%. All trees (height >3 m) and shrubs (1.5–3 m) within each subplot were counted in order to obtain stem density estimates.

Composite soil samples were collected at each plot using soil augers, combining topsoil (0–20 cm) samples from each of the four subplots into one sample, and the four subsoil (20–50 cm) samples into one subsoil sample per plot, giving a total of 320 samples per site. In addition, cumulative and undisturbed soil samples were collected in four depths (0–20 cm, 20–50 cm, 50–80 cm and 80–110 cm), totaling 480 samples per sites. All the collected samples were processed and subsamples were shipped to the Soil-Plant Spectral Diagnostics Laboratory of ICRAF in Nairobi, Kenya. Collected soil samples will be analyzed using the mid-infrared (MIR) reflectance according to procedures described in Terhoeven-Urselmans et al. (2010). Regression analysis will use MIR data as independent variables,

5 http://www1.cifor.org/fileadmin/subsites/sentinel-landscapes/document/Association_Form_A.pdf

6 http://www1.cifor.org/fileadmin/subsites/sentinel-landscapes/document/SL_Product_Form_R.pdf

7 http://www1.cifor.org/fileadmin/subsites/sentinel-landscapes/document/SL_Household_Module.pdf

Table 2. Summaries of sampling plots, soil samples and infiltration rates

Sentinel site	Number of sampling plots	Standard soil samples	Cumulative soil samples	Number of infiltrations
Ediolomo (Bokito)	160	320	420	48
Ayos	160	320	420	48
Kongo (Lomie)	160	320	420	0
Meyiboto (Mintom)	160	320	420	0
Total	**640**	**1280**	**1680**	**96**

and the laboratory data from 10% of the samples as dependent variables. Infiltration measurements were made in three plots within each cluster to give a total of 48 infiltration per site.

All the landscape information was assessed with the help of a Global Positioning System (GPS-Trimble Juno 3D) in which an electronic data-entry system built on the CyberTracker platform was installed. The summary of soil samples and infiltration data is in Table 2.

Human health

As health is one of the main SLOs of CGIAR's work, we initiated a preliminary study on this issue in our SL. Because of budget constraints, we were only able to work on two of the four sites. The emphasis here was placed on the preliminary study and the production of draft guidelines, which may be useful for other sentinel landscapes. Bokito and Ayos were thus retained for this preliminary study on health.

Bokito site: The team worked in the following villages: Tchekos, Bokaga, Ediolomo and Mbela. The sites were chosen based on the presence of a health center since we needed to present the epidemiological profile of each site. We also took into consideration a difference in the vegetation and the proximity of the forest. The accessibility of the villages was also taken into account given the prevailing rainfall and the state of the roads.

Ayos site: The survey took place in these four villages: Obis, Olembe, Mbang Oyebo'o and Ndelle. These villages were chosen following the same criteria as for the Bokito site: presence of health for epidemilogical profile data, difference in vegetation, proximity of forests, and accessibility of the villages. The methodology involved the use of surveys, direct observations and document consultations to extract information.

3 Review of other projects co-located or linked to CAFHUT

The Central African Humid Tropics Sentinel Landscape (CAFHUT) site was selected through a collaborative effort of scientists from Bioversity International, CIFOR, ICRAF and CIRAD. Besides CAFHUT research, some partners carried out parallel activities in the landscape. This section will systematically map out and analyze the research activities that different research and development partners have conducted in the landscape over the past 10 years. The report also makes a link between research activities carried out in the landscape and those planned in 2012. Specifically, the report highlights the background and purpose for different interventions by partners, describing their major development achievements as well as the challenges identified in the landscape. The knowledge generated is also reported through publications.

The reported information was sourced from key FTA partners, including Bioversity International, CIFOR, ICRAF and CIRAD. The lead researchers from each of these institutions who supervised projects in the sentinel landscape provided the required information. In cases where the lead researchers were not available, data were obtained from online sources, using Google and consulting the websites operated by some of the projects and partners.

3.1 Summary of projects based on themes characterizing major development challenges in the landscape

This section summarizes project findings that address the three major development challenges/opportunities that denote the landscape, including deforestation; cocoa intensification and diversification; and poverty reduction. See Annex A for details on projects reviewed.

3.1.1 Deforestation and land use dynamics

Several projects monitored deforestation and the carbon sequestration potential along different patches in the CAFHUT landscape. The CoForTips[8] project assessed the vegetation in Mindourou and Guéfigué with the aim of identifying points for biodiversity conservation and the resilience of forested social and ecological systems. Over the entire study area, satellite images (Landsat and SPOT) were used to account for land-use dynamics. Results projected that deforested areas will increase twofold over the period 2020–2030 compared with the period 2000–2010 due to increasing populations and higher average consumption per capita. The results also showed that cassava, groundnuts and maize are the main crops responsible for cropland expansion, and the area dedicated to palm oil cultivation will also double from 2010 to 2030.

Analysis of deforestation and degradation by the ASB-REALU team (see Table 3) shows that deforestation and forest degradation in the CAFHUT landscape are caused by a combination of drivers, including land conversion for small-scale subsistence and market-based agriculture; conversion for agro-industry and plantations (oil palm,

8 CoForTips Project: https://www.cofortips.org/en/the-products/reports

banana, rubber); mining; infrastructure development; and all types of logging schemes (industrial, artisanal, legal and illegal). The research demonstrated that there are some challenges to developing an accurate understanding of how land cover is changing. Most of the challenges are due to technological limits but are also complicated by an unclear definition of what legally qualifies as 'forest.' More research is needed to understand the spatial and temporal patterns and the synergies among the various drivers.

Table 3. Deforestation-related projects

No.	Project	Research institution	Location
1	Reducing emissions from all land uses (REALU). Linking development pathways and emission reduction at local levels: Feasibility assessment of emission reductions in Efoulan municipality in Cameroon	ICRAF, IITA, IRAD	Nyong and So'o, Ocean, Mvila, and Valee du Ntem
2	Opportunities for avoided deforestation with sustainable benefits in central plateau of Cameroon, Guinean-Congolian forest margins (2009-2011)	CIRAD	Awae and Akok
3	Congo Basin Forests: Tipping Points for Biodiversity Conservation and Resilience of the Forested Social and Ecological Systems (CoForTips and CoForSet projects)	CIRAD	Mindourou and Guéfigué

3.1.2 Cocoa improvement, intensification and diversification

Several projects have been carried out in the Bokito site, which is characterized by forest-savanna vegetation where secondary forest is used for growing cash and subsistence agricultural and agroforestry crops. Projects implemented in this site included STRADIV[9] (2016–2018), SoCa (2018–2020), SAFSE[10] (2012–2015), and Agroforestry for Food Security (2012–2015). The objectives of these projects varied, but their central themes were to identify the effect of past land uses (forest and savanna) on the current ecosystem multi-functionality of cocoa agroforestry systems while gaining more insights into the sustainability of those systems. The STRADIV project, for example, showed that over a period of about 80 years, there has been a steady increase in both aboveground carbon (AGC) and soil organic carbon (SOC) after converting savanna into cocoa agroforestry systems (AFS).

Part of the SAFSE project involved characterizing the arboreal arthropod community in cocoa-based agrosystems. Results from Tchoudjin (2014) in the locality of Bokito showed that a total of 16 invertebrate orders were identified from a set of 33,900 individuals collected on the four prospected plots. The order Hymenoptera (with relative abundance of 93, or 10%) dominated, along with Formicidae. The ant fauna reported was composed of 60 species belonging to six sub-families and 21 genera, dominated by the Myrmicinae sub-family with 72, or 70% abundance.

The Agroforestry for Food Security project executed in Bokito and Talba explored the effects of trees on soil quality conservation in AFS-containing food crops. The results showed that (a) among all the soil characteristics checked, significant soil quality indicators were phosphorus, C/N ratio, ferrous ion (Fe^{2+}), silt and soil organic carbon; (b) the soil degradation index (SDI) calculated

9 STRADIV Project: https://stradiv.cirad.fr

10 SAFSE project: https://safse.cirad.fr/en/publications/reports

from those soil analyses decreased with AFS age; (c) soils from AFS were in a relative state of equilibrium regardless of their age; and (d) soils of AFS built on savanna are able to 'catch up' with soils of forest-based AFS while aging. An assessment during a one-year period in cocoa-based AFS in Bokito indicated that potential cocoa yield on average is 819.2 kg/ha.

The Pro-Intens Africa[11] (ProCISA) project, running from 2015 to 2021, surveyed the constraints faced by small cocoa farmers in three cocoa-producing areas, and the options currently adopted for reducing these constraints. It also examined their perception of intensification and their needs to intensify their cocoa plots. The results showed that a large range of cocoa yield is observed on small farmers' plots, ranging between very low (around 100 kg/ha/year) to very high (2000 kg/ha/year), with average values varying between 300 kg/ha/year (in Lekie, Mbam and Inoubou) and 600 kg/ha/year in Mbam and Kim. The results from the survey also reveal that small cocoa farmers are aging or old. The project trained farmers on good cocoa production practices, intensification as well as on the multiplication and distribution of planting materials. Climate-smart cocoa plant propagation centers were established while bio-pesticides and pheromone technology for mirid management were examined.

Some activities were carried out in sites on the CAFHUT landscapes described as degraded mature landscape forest. Forest concession and community forests are common on this site Timber exploitation is one of the main activities influencing the forest structure in the area. The project on promoting sustainable agriculture (REDD+) around Lobéké and Dzanga Ndoki national parks (2017–2018) focused on strengthening farmers' capacities for sustainable agriculture. This was to be done through the selection and propagation of high-value tree species; the on-farm integration and management of trees; and the promotion of integrated soil fertility management. The project established offshoot nurseries in the pilot communities. Diversified cocoa plantations were also established in the various communities. A total of 27 plots were set up around the two protected areas. Lastly, seven demonstration plots were put in place when the project was started in the communities around Lobéké and Dzanga Ndoki national parks for integrated soil fertility management.

Table 4. Cocoa-related projects

No.	Project	Research institution	Location
1	Incentives for cocoa intensification through tree improvement and domestication as a strategy of reducing pressure on forest in Efoulan, Cameroon: ASB[12] project (2009–2013)	ICRAF, IITA, IRAD	Efoulan
2	Beyond climate, soil carbon sequestration to sustain family farming in the tropics: SoCa project (2018–2020)	CIRAD/ ICRAF	Bokito
3	Green innovation centers for the agriculture and food sector (ProCISA): ProIntens Africa project (2015–2021)	CIRAD	Lekie, Mbam and Inoubou and the Mbam and Kim divisions
4	Plant diversification in agroecosystems: ecosystem services supporting crop productivity: The STRADIV project (2016–2018)	CIRAD	Bokito

11 https://www.worldcocoafoundation.org/wp-content/uploads/files_mf/14855361542016ResearchSymposium_Day3RachidIITA.pdf

12 http://www.asb.cgiar.org/project/opportunity-costs-avoided-deforestation-sustainable-benefits - http://www.asb.cgiar.org/PDFwebdocs/CAMEROON_REALU.pd

The REALU project carried out cocoa extension activities in a similar site combining the two scenarios applying cocoa extension and sustainable forest management. In 2015, for example, a total of 2760 trees were integrated into cocoa agroforestry systems in Efoulan and more than 600 people declared their willingness to adopt new cocoa models on 3000 ha of new farms. Impressive results were also obtained in the adoption of sustainable intensification pathways within cocoa agroforestry systems as a strategy to reduce pressure on the forest.

3.1.3 Poverty reduction

In general, poverty remains an issue in the entire landscape. While the overall goal of the projects described above is to address poverty, some of the projects specifically addressed livelihoods. The ProIntens Africa (ProCISA) project targeted innovations in the agriculture and food sectors and aimed to increase the income of small farming enterprises. In addition, the project boosted employment and food supply in the rural areas targeted. It also focused on supporting the intensification of cocoa farms and improving agricultural practices by creating farmer field schools. Almost 5700 farmers were trained in Cameroon in 2016–17.

One of the objectives of the ASB project was to raise productivity and the incomes of rural households in the humid tropics without increasing deforestation or undermining essential environmental services. Results indicated that 75% of the farmers interviewed in Talba cultivate food crops, while this proportion is 100% in Bokito. In Talba, household relative income from cocoa varies from 85% on small farms to 100% on large farms. Additional results revealed that fruit trees (especially citrus) are more common in some of the sites of the landsacpe. In Bokito, for example, these fruit trees play a major role in food security and diversity through direct consumption or an increase in income from the sale of fruit from trees.

In some sites of the landscape, such as in Ayos, various projects – e.g. agroforestry tree products for Africa – were carried out to increase, diversify and stabilize the incomes of poor small-scale farmers by increasing their participation in – and benefits from – the value chains for agroforestry tree products (AFTPs) and non-timber forest products (NTFPs). After 4.5 years of project implementation, it was found that vegetative propagation and on-farm cultivation of target species can effectively contribute to sustained quality production and therefore play an important role in improving value chains. Policy research on the cultivation and commercialization of NTFPs/AFTPs was conducted on this project, providing useful insights into the constraints and opportunities associated with agroforestry.

Table 5. Projects related to poverty reduction

No.	Project	Research institution	Location
1	Financing sustainable community forest enterprises in Cameroon (DRYAD)[13]	ICRAF	Itali, Bimbia Bonadikombo and Etinde; Akwen-Agborkem and Ngambe-Tikar, Ngoyla, Mindourou, Lomie, Bokito, Ndikimineki, Deuk, Awae, Edea
2	Promoting sustainable agriculture (REDD+) around Lobéké and Dzanga Ndoki national parks (2017–2018)	ICRAF	Yenga, Socambo, Mongokélé, Mbantekadjong, and Mang
3	Agroforestry for food security (AFS4FOOD)[14] project (2012–2015)	CIRAD	Bokito and Talba
4	Agroforestry Tree Products for Africa (2009–2013).	ICRAF	Ayos

13 http://www.asb.cgiar.org/project/dryad-financing-sustainable-community-forest-enterprises-cameroon

14 AFS4FOOD project: http://afs4food.irad.fr/en

Thematic analysis of projects carried out in the Central African Sentinel Landscape

This section is a critical summary of projects carried out in the sentinel landscape. They are grouped into the four landscape themes: socioeconomic, institutional, biophysical and health.

3.1.4 Analysis of socioeconomic projects

The socioeconomic projects were to be executed in the four sites of the landscape: Ediolomo (Bokito), Ayos, Kongo (Lomie) and Meyiboto (Mintom). The socioeconomic baseline projects in the landscape aimed to examine the main livelihoods; food consumption and composition; food scarcity; assets and incomes; food security; improved production; harvest and post-harvest techniques; and the value chain of various products. The different projects executed in the landscape were directly concerned with one or more socioeconomic aspects.

The Agroforestry Tree Products for Africa project (2009–2013) carried out in Ayos aimed to increase, diversify and stabilize the incomes of poor small-scale farmers in West and Central Africa by increasing their participation in – and benefits from – the value chains of agroforestry tree products (AFTPs). The first aspect of the project was to develop and promote improved production techniques for each of the target species in order to ensure the supply of quality products. As far as this aspect was concerned, *Gnetum africanum* was domesticated. The major activities carried out on *Gnetum africanum* included the morphological characterization of vines from four provenances; vegetative propagation; and on-farm cultivation. The project undertook the characterization for leaves, vine cutting and the development of options for the on-farm integration and management of *Gnetum*. The project also examined harvest and post-harvest strategies of NTFPs in Ayos. The main aim of this component was to develop appropriate harvest and post-harvest techniques for each of the target products in order to ensure the supply of quality products and to add value to products. Harvest and post-harvest activities concerned four products: njansang (*Ricinodendron heudelotii*), bush mango (*Irvingia spp.*), kola nuts (*Cola spp.*) and safou (*Dacryodes edulis*). Harvest and post-harvest strategies were different for each of the target products with a view to solving major bottlenecks. The stages involved in the harvesting of njansang and bush mango were analyzed, and machines were introduced to that effect. Group members were sensitized to use the tool and the level of success of the machines was analyzed by the project. Socioeconomic analysis of the prototype of a njansang cracking machine – four years after its introduction in Epkwassong (Central region of Cameroon) – showed that mechanical extraction of njansang kernels (42 min/kg) is faster than manual extraction (60 min/kg). Lastly, the project carried out a value-chain analysis of some NTFPs. The main activities included: (a) analyzing value chains in order to identify actors, costs, benefits, opportunities and constraints related to the marketing of the product; (b) strengthening producers and traders so that they can engage in collective action and link up with each other; and (c) developing and testing financial mechanisms to overcome some of the barriers that both producers and traders face when they try to increase their participation in value chains.

The project on promoting sustainable agriculture (REDD+) around Lobéké and Dzanga Ndoki national parks (2017–2018) had a socioeconomic component: the promotion of bee keeping. This component – contrary to other components of the project – ended at the training-of-trainers level because this was not planned at the beginning of the project. It was recommended during the last implementation period, following requests from beneficiaries, who reportedly now have the skills to capture bees and manage colonized hives.

The Agroforestry for Food Security (AFS4FOOD) project – executed from 2012 to 2015 – aimed to enhance the food security and well-being of rural African households through improved synergies between agroforestry systems and foodcrops. The specific objective was the characterization of farming systems and identification of long-term drivers at household and landscape levels. The project was carried out in Bokito and Talba and sought pathways to improve synergies between agroforestry systems and food crops at plot level. The surveyed farms showed that other activities beyond cocoa were contributing significantly to the overall household economy. These activities were in magnitude of importance: staple food production, cattle breeding and non-agricultural work. On the surveyed farms, cocoa is the highest contributor to family income. On average, it provides 76% of total household income in Talba, but only 38% in Bokito. The Household Dietary Diversity Score (HDDS; Swindale and Bilinsky 2006) did not show any differences between villages. Yet, the Household Food Insecurity Access Scale (HFIAS; Coastes et al. 2007) showed a significant difference between villages, with 21% and 12% of households being considered as food secure in Bokito and Talba, respectively. Altogether, these results seemed to show that: (a) cocoa growing did not contribute significantly in economic terms to food security in the two villages; and (b) on-farm diversification in Bokito helped to raise the numberof households that achieved food security. A significant part of households' food provisions can be supplied by associated trees found in cocoa-based AFS. The use of food-producing trees in agroforestry systems seems to be widespread among surveyed households, particularly in Bokito, despite their acknowledged competition with cocoa. Another aspect of the project examined the major farming activities in Bokito and Talba. The results obtained by Bakemhe (2014) showed that cocoa is the main farming activity, representing 89% of cultivated areas and 59% of household agricultural income in Talba, while 41% of household income is from food crops. In essence, food crops use only 11% of cultivated lands but produce 41% of the revenue. In fact, for the same area of 1 ha, the more profitable system is the intercropping of groundnut-maize. In Talba, food crops are directly used for the farmers' families and only the excess is sold, while cocoa is produced only for sale, and the income is used for various purposes (nutrition, health, education and others).

The CoForTips project examined the major socioeconomic activities in Bokito, Mindourou and Guefegue. In the Congo Basin forests, many people are still living from hunting, fishing and gathering, as well as slash-and-burn agriculture. But the development of roads, towns and markets is providing new opportunities that local communities are quick to grasp. The landscape transformation and the loss of forest are also accompanied by changes in households and family farms. The CoForTips team examined the technical and economic performances of family farming and extractive activities in the forest. The team explored the household strategies as well as the standards and tenure types of different natural resources. In the end, the project provides a coherent vision of how societies living in forests adapt to change and manage their landscape. Far from being passive subjects, local communities are themselves actors and drivers of change. Results reveal that hunting, fishing, collection of NTFPs, and agriculture remain the key income-generating activities in this area. The findings indicated that about 70 different NTFPs are collected in each site in Mindourou, but differences existed in Guefegue. Results also showed that hunting is carried out using tools such as traps, guns, spears and dogs for a variety of animals, including blue duikers, monkeys, guinea fowls, pangolins, grasscutters, rats, shrews, Sciuridae (squirrels), civets, quail, genets, snakes, gorillas, chimpanzes, sitatunga, bongos, turtles and partridges. In Mindourou, 64% of the bush meat is sold, while animals caught in Guéfigué are essentially for one's own consumption. The survey indicated that fishing is one of the livelihood activities in the area carried out by both men and women in deep and narrow rivers. Farming systems were analyzed during the project, with the cultivation fields including: cassava fields (cassavas, maize, plantains) cultivated for 3 years with a fallow period of 10–15 years; peanut fields (groundnuts, maize, cassavas) cultivated for 2 years with a fallow period of 2 years; and plantain-banana fields (plantains essentially) cultivated for 2 years with a fallow period of more than 15 years.

The DRYAD (Financing sustainable community forest enterprises in Cameroon) project focused on providing viable community forest enterprises (CFE) with sustainable livelihoods and environmental benefits through performance-based public finance and support mechanisms. Results show that 29 communities are now involved in the project with a population of 31,600, and 34 CFEs are engaged in the investment portfolio, representing 646.6 million XAF. The 29 CFEs cover a forest area of about 100,000 ha. Three-and-a-half years into the project, CFEs have started generating revenue: ADNG sold njansang worth 2,648,750 XAF, while CODEM sold cane products worth 300,000 XAF. The latter has entered into an agreement with one of the largest supermarkets in Yaoundé.

The analysis suggests that almost all the socioeconomic aspects of the sentinel landscape highlighted for research were examined by different projects. These included main livelihood activities; food consumption and composition; food scarcity; assets and incomes; food security; improved production; harvest and post-harvest techniques; as well as the value chain of various products. However, the above-mentioned activities were not all covered on one site. The socioeconomic projects were executed in only three of the four selected sites: in Mintom (Mindourou and Guefegue), Bokito and Ayos. The landscape stakeholders/partners did not carry out any socioeconomic project in the sites of Lomie-Kongo.

3.1.5 Policy and institutional analysis

Analysis of the policy and institutional context in which the production and commercialization of AFTPs occur was a crucial element for the success of the Agroforestry Tree Products for Africa project. Much of the research was carried out by Divine Foundjem Tita (2013) in his doctoral thesis, titled "New Institutional Economic Analysis of Policies Governing Non-Timber Forest Products and Agroforestry Development in Cameroon."

The main objective of the study was to assess the policy and institutional environment governing the value chains of NTFPs and AFTPs in Cameroon. Another aim was to find out the effects of such policies and regulation on traders' activities, paying attention to their decisions on whether to operate in the formal or informal sector, and the consequences of their decisions for the performance of the value chains. The main NTFPs studied were *Irvingia gabonensis, Ricinodendron heudelotii* and *Cola spp.*

The results illustrate the commitment of Cameroon's government to include elements of NTFPs in its polices on natural resource management and poverty reduction, therefore indirectly promoting agroforestry. However, such intentions are not evident in specific programs or strategies. For example, an analysis of policy documents and mission statements of the relevant ministries in charge of agriculture, forestry, the environment and other rural development issues indicates that no specific agroforestry policy or strategy document exists for Cameroon. A consequence of the latter is that numerous afforestation and reforestation programs addressing environmental issues often overlook the important role that an agroforestry strategy plays in balancing the interaction between crops, animals and trees on a piece of land. Such a balance is the essence of agroforestry.

Results also show that the 1994 Forestry Law – the forestry legislation that applies to trees in Cameroon and was designed with the good intentions of conserving natural resources – potentially limits farmers' economic rights to exploit NTFPs and effectively restricts their rights to the trees they plant on their farms. The findings show that farmers are generally unaware of the official regulations governing access and trade in the studied species. Even though most of them demonstrated negative attitudes toward the regulations, a majority would continue to plant the studied species if the regulations were effectively enforced because indigenous fruit trees are part of their traditional agricultural practices and play a major role in their livelihoods.

Results also show that most farmers are ready to accept new policy instruments, such as certificates of origin, to distinguish AFTPs from NTFPs. This is a major gap in the current legislation and in regulations governing indigenous trees in Cameroon.

Institutional arrangements in the demand and supply of permits in the NTFP sector were also examined. Factors motivating noncompliance are generally related to high transaction costs characterized by a high nominal amount to be paid for the permit, limited access to information and complicated bureaucratic processes involving corruption and rent-seeking police or forestry officers, as well as rich economic operators. It was concluded that noncompliance with the law on permits is a rational choice by traders to overcome high costs. By paying bribes, they achieve more benefits than what they may gain if they opt for permits. The conditions under which transaction costs could be reduced in the current system of delivering NTFP permits were then assessed. The choice model applied to assess policy options revealed that traders would comply with the law on permits under the following conditions: (i) Common Initiative Groups (CIGs) should be recognized as organizations eligible to obtain permits; (ii) the permit system has to be simplified and decentralized to the regions; (iii) transfers between permit holders should be allowed; and (iv) the duration of the permit should be increased by at least one year. In addition, the study found that simplifying paperwork and decentralizing the process to the regions was the most valued alternative selected by traders.

A review of policies governing access and trade in NTFPs and on-farm trees demonstrate that such legislation contradicts efforts encouraging tree planting. For example, traders in agroforestry products complain about harassment of police and officials from the Ministry of Forests and Wildlife who ask for their permit to exploit, transport and sell NTFPs, as stipulated in the Cameroon Forest Law No. 94-1 of 20 January 1994. However, procedures to obtain such a permit – being the same as for the exploitation of timber – are complex, costly and beyond the capacity of most traders in AFTPs, who are often operating at a small scale.

3.1.6 Analysis of biophysical projects

Four sites were retained for the biophysical projects: Ediolomo (Bokito), Ayos, Lomie-Kongo and Meyiboto (Mintom). The biophysical project in the sentinel landscape had the following main objectives: soil surface characterization; vegetation assessment and measurement; soil sampling; soil texture; visible soil erosion; soil infiltration capacity; landform and land cover classification; and woody cover.

One of the components of the CoForTips project was to carry out vegetation assessment and measurement of vegetation in Mindourou and Guéfigué. The objective was to identify the tipping points for biodiversity conservation and resilience of forested social and ecological systems. The principal floristic and functional forest types in the area and the model for environmental and anthropogenic determinants using advanced statistical methods were assessed. A local-scale remote-sensing analysis of the land-use changes was conducted based on a diachronic analysis of Proba-V images available over about three decades in three different village territories experiencing various intensities of anthropogenic pressure in the region. The project also produced hybrid maps for cropland, humid forests and dry forests. These maps indicated the cultivable areas for oil palm, potatoes (*Solanum tuberosum*), sweet potatoes (*Ipomoea batatas*), yams, beans, groundnuts, cassavas, peanuts, millet and sorghum. A map indicating the biophysical potential of oil palm in the Congo Basin was produced. The project also produced a map indicating simulated deforestation from 2010 to 2030 (in million ha/year) using different GDP growth projections. The risk of deforestation in the Congo Basin was also studied using the global economic model GLOBIOM, which focuses on agriculture and forestry activities. Preliminary results show that the deforested area in the period 2020–2030 is likely to be twice as large as that for the period 2000–2010 due to a rising population and higher average consumption per capita. From our results, cassavas, groundnuts and maize are the main crops responsible for cropland expansion, and the area dedicated to the cultivation of palm oil will also double from 2010 to 2030. Forests in the littoral regions and in central Cameroon are projected to be under increased pressure in the coming decades. A second aspect of this work was to model vegetation dynamics in the three study sites selected by the project. On the site of Mindourou, actors develop more intensive agricultural activities, with the rise of commercial agriculture in areas further away from villages. The site of Guéfigué, on the other hand, is characterized by a recent increase in wooded areas for the development of cocoa agroforestry. Over the entire study area, we used satellite images (Landsat and SPOT) to account for the dynamics of land use. On a smaller scale, we mapped the agricultural parcel using object-oriented methods. The transition model for savanna-forest in Guéfigué was produced.

The Pro-Intens Africa (ProCISA) project targeted innovations in the agricultural and food sectors and ways to increase the incomes of small farming enterprises. In addition, the project aimed to boost employment and improve food supply in the rural areas targeted. It also focused on supporting the intensification of cocoa farms and enhancing agricultural practices through the creation of farmer field schools. Almost 5700 farmers were trained in Cameroon in 2016–2017. The survey allowed the team to gain information on the constraints faced by small cocoa farmers in three cocoa-producing areas; the options currently adopted for reducing these constraints; as well as their perception of intensification and their needs to intensify their cocoa plots. The results showed that cocoa yields on small farmers' plots range between very low (around 100 kg/ha/year) and very high (2000 kg/ha/year), with average values varying between 300 kg/ha/year (in Lekie, Mbam and Inoubou) and 600 kg/ha/year in Mbam and Kim. The results from the survey also revealed that small cocoa farmers are aging or old. The proportion of young farmers (under 40 years old) was less than 30%. About 120 cocoa farms were also characterized, with an analysis of the cocoa value chain and markets. The project trained farmers on good cocoa production practices, intensification as well as on the multiplication and distribution of planting materials. Climate-smart cocoa plant propagation centers were established, while biopesticides and pheromone technology for mirid management were examined. Diversity characterization and conservation of cocoa pollinators were also carried out.

The SoCa project assessed carbon (C) sequestration in the different cocoa agroforestry systems in relation to organic matter, nitrogen (N) and phosphorus (P) dynamics (including production) and soil functioning in two climate situations. The main activities in the Bokito site were the identification of cocoa system trajectories and farmers' practices; assessment of C sequestration in soil and biomass according to different agroforestry trajectories; different land uses (previous and other land uses) in relation to organic matter as well as N and P dynamics and the spatial impact of trees on soil parameters. The project examined how carbon in the soil is removed after creating cocoa plantations on savanna; the potential of cocoa systems in savanna for increasing the ecosystem functions, not only of carbon but also soil quality parameters; how agroforestry canopy can sustain cocoa production in the long term; the effects of different types of cocoa species on ecosystem functions, carbon production and soil quality in relation to functional trade; measurements of canopy cover in Bokito to characterize the system and its effects on ecosystem functions and to examine high and low tree-canopy cover in the area. The project is still ongoing in the area.

The ASB project aimed to raise the productivity and incomes of rural households in the humid tropics without increasing deforestation or undermining essential environmental services. The first aspect of the project explored the opportunities for avoided deforestation with sustainable benefits in the central plateau of Cameroon and in the Guinean-Congolian forest margins. Land cover maps of Akok and Awae were also produced on this project. An analysis of land use change was developed for Awae and Akok villages from aerial photographs for 1984 and high-resolution IKONOS satellite imagery for 2001.

The REALU project, which is part of the ASB project, carried out a feasibility study of emission reductions in the Efoulan municipality of Cameroon. A map of land use changes in the municipality from 2001 to 2007 was produced while the land use dynamics and associated carbon stock changes were evaluated. Four scenarios were developed for simulation: 'BAU' reflected the current trend from the historical baseline if no measures are taken to reduce emissions at the landscape level; 'Cocoa Extension' reflected the current interest of the government and the local population in increasing cocoa production by extending the cocoa farms in the area; and 'Sustainable Forest Management' involved the implementation of good forest-management strategies (such as reforestation and reduced impact logging) in production forest, community forest and communal forest. The project also constructed a scenario combining cocoa extension and sustainable forest management whereby intensification through the input and integration of timber and fruit trees is applied in the cocoa plantations, while afforestation/reforestation and reduced-impact logging practices are applied in forested areas.

Analysis of deforestation and degradation by the ASB-REALU team shows that deforestation and forest degradation in the CAFHUT landscape are caused by a combination of drivers, including land conversion for small-scale subsistence and market-based agriculture; conversion for agro-industry and plantations (oil palm, banana, rubber); mining; infrastructure development; and all types of logging schemes (industrial, artisanal, legal and illegal). The research demonstrated that there are some challenges to developing an accurate understanding of how land cover is changing. Most of the challenges are due to technological limits but are also complicated by an unclear definition of what legally qualifies as 'forest.' More research is needed to understand the spatial and temporal patterns and the synergies among the various drivers.

The REALU team also demonstrated that to set up efficient emission-reduction strategies, stakeholders in the CAFHUT landscape need to develop strong cross-sectoral collaborations and look for solutions outside the forest, within the agricultural sector, which is one of the key sectors driving land use change at the tropical forest margins. One of the options for reducing forest degradation involves on-farm trees, which can provide farmers with a sustainable source of timber, thus reducing their need to harvest from the forest. The ASB-REALU team also investigated how adding on-farm trees could help increase the amount of carbon stored in the agricultural mosaic while improving farmer livelihoods. In the Efoulan landscape, for example, incentives for cocoa intensification through tree improvement and domestication were promoted as a strategy to reduce pressure on forest. Yemefack et al. (2012) found that a typical cocoa agroforestry system in the Efoulan municipality contains about 180 tons of carbon per hectare. Such agroforestry systems could help reduce the pressure on forests by providing a source of wood for energy fuel and construction (which can be an additional source of income and act as an adaptive measure in the case of crop failure) and by increasing cocoa productivity, thereby reducing incentives to clear more forests for plantation expansion. Emission reductions were estimated to be around 499.8–507.8 tCO^2/year for a farm of 2.71 ha with 20-year-old tree species planted within the agroforestry systems.

From 2013 to 2015, technical support was provided (in the form of tree domestication and improvement techniques) to cocoa farmers in Efoulan as a non-financial incentive scheme to intensify the cocoa agroforestry system. Six main training sessions were given to cocoa farmers in Efoulan. Technical support was delivered in the form of (i) nursery creation; (ii) training on vegetative propagation techniques, such as cuttings, marcotting and grafting; (iii) construction of shades for seedlings; and (iv) integration of seedlings and young plants obtained from nurseries between cocoa trees. Support was also provided to farmers in the form of polyethylene bags, water tanks (200 litres, used to store water during periods of scarcity), watering cans, sprayers, secators, scissors, improved germplasm (or seedlings), and pesticides. There was also training of trainers.

In 2015, a total of 2760 trees were integrated into cocoa agroforestry systems in Efoulan and more than 600 people declared their willingness to adopt new cocoa models on 3000 ha of new farms. Impressive results were obtained in the adoption of sustainable intensification pathways within cocoa agroforestry systems as a strategy to reduce pressure on the forest.

The STRADIV project in Bokito aimed to identify the effect of past land cover (forest and savanna) on current ecosystem multifunctionality of cocoa agroforestry systems, and to gain more insight into the sustainability of those systems as well as the dynamics driving the sustainability. The study showed that over a period of about 80 years, there was a steady increase in both aboveground carbon and soil organic carbon after converting savanna to cocoa AFS. The length of the studied chronosequences makes it possible to demonstrate that aboveground carbon (AGC) stocks of savanna-derived Cocoa Agroforestry Systems (S-cAFS) are similar in amount to those of forest-derived Cocoa Agroforestry Systems (F-cAFS) in the long term. On the other side, conversion from degraded forest patches to F-cAFS led to a ca. 40% reduction in AGC, with minimum maintenance in the long term. In S-cAFS, considering a period of about 80 years after afforestation, the average annual increase in SOC concentration in the 0–15cm layer ranged from 7.3% in soils with low clay content to 9.5% in soils with higher clay content (Nijmeijer et al. 2018). The project also reviewed soil fertility. The abrupt conversion from forest to F-cAFS meant that most ecosystem functions, except soil fertility, changed rapidly. After 15 years of installation, most of the ecosystem functions (biomass, litterfall, stock and soil fertility) in cAFS, set up after savanna, shifted to get great similarities with cAFS set up after forest. Those cAFS showed sustainable accessible production in the long term (Nijmeijer et al. 2019).

The Agroforestry for Food Security project – executed in Bokito and Talba – explored the effects of trees on soil quality conservation in AFS containing food crops. The results showed that (a) among all the soil characteristics checked, significant soil quality indicators were phosphorus, C/N ratio, ferrous ion ($Fe2+$), silt and soil organic carbon; (b) the soil degradation index (SDI) calculated from those soil analyses was decreasing with AFS age; (c) soils from AFS are in a relative state of equilibrium regardless of their age; and (d) soils of AFS built on savanna are able to ‘catch up’ with soils of forest-based AFS while aging. The project carried out an assessment of potential cocoa yield over a one-year period in cocoa-based AFS in Bokito. The findings indicated that potential yield in Bokito averaged 819.2 kg/ha. There was no significant difference in yields with respect to preceding land occupation, but there was significant difference with respect to the age of the farm. Characterization of the microclimatic (humidity and light) conditions and the impact of pests and diseases constituted part of the project. Shade has an impact on microclimate in the sub-plots: An increasing shade level results in a decreasing temperature and increasing relative humidity during daytime only. The same trend is observed when the daily period of shade lasts longer. An assessment was carried out on the diversity of natural enemies, such as *Phytophthora megakaraya*, with specific assessment of insect diversity in different types of cocoa plots and an analysis of the impact that mirids have on cocoa yields. The quality of AFS products at plot level in Bokito was also characterized.

Concerning the soil surface characterization, cocoa plots are usually the main component (85%, on average) of farms in Talba, but their relative importance is even higher (up to 100%) on large farms. They represent 50% to 75% of the cultivated area of farms in Bokito, in which mostly staple food crops are cultivated. About 75% of the farmers interviewed in Talba cultivate food crops, while the proportion is 100% in Bokito. In Talba, the household revenues from cocoa vary from 85% on small farms to 100% on large farms. Findings revealed that the diversity of trees in AFS is significantly lower than in forests; associated trees are the main contributors of carbon storage in AFS and the carbon storage is highest at maturity (e.g. between 40 and 65 years old). In Bokito, carbon storage of associated trees can be considered equivalent to that of local forest. Diversity of associated trees tends to decrease with age and AFS since farmers make trade-offs between the services they provide and cocoa production. Cocoa-based AFS are able to combine high levels of tree diversity with long-term conservation abilities and carbon storage.

The project on promoting sustainable agriculture (REDD+) around Lobéké and Dzanga Ndoki national parks focused on strengthening farmers' capacity to pursue sustainable agriculture through: (a) the selection and propagation of high-value tree species; (b) the integration and management of on-farm trees; and (c) the promotion of integrated soil-fertility management. The project established off-shoot nurseries in the pilot communities. Diversified cocoa plantations were also set up in the various communities. The objective of the agroforestry component of this project was land rehabilitation, with a focus on degraded lands among the farms of active group members. The main targeted land-use systems were secondary forest and fallow. A total of 27 plots were set up around the two protected areas. Lastly, seven demonstration plots were put in place when the project was started in the communities around Lobéké and Dzanga Ndoki national parks for integrated soil-fertility management.

The SAFSE project aimed to characterize the arboreal arthropod community in cocoa-based agrosystems. Results from Tchoudjin (2014), in the locality of Bokito, showed that a total of 16 invertebrate orders were identified from a set of 33,900 individuals collected on the four prospected plots. The order Hymenoptera (with relative abundance of 93, or 10%) dominated, along with Formicidae. The ant fauna reported was composed of 60 species belonging to six subfamilies and 21 genera, dominated by the Myrmicinae subfamily with 72, or 70% of abundance. The second aspect studied was the effect of shading on microclimate, brown rot, mirid and productivity in the cocoa-based agroforestry system. An analysis of possible improvements to AFS through technical and institutional innovations was also carried out.

It can be seen from the aforementioned analysis that many of the projects tackled the biophysical aspects of the landscape. The biophysical projects focused on soil surface characterization; vegetation assessment and measurement; soil sampling; soil texture; visible soil erosion; soil infiltration capacity; landform and land cover classification; and woody cover. The analysis suggests that different projects focused on one or more of these aspects, but for the socioeconomic perspective no single site benefited from a combination of all research objectives under this component. While it may not be necessary, it is important that subsequent projects on the selected sites address a combination of research questions so that a better and more comprehensive assessment can be made of the landscape.

3.1.7 Analysis of human health projects

Two sites were selected for the health projects: Bokito and Ayos. Some fieldwork was initiated to exchange information with health-related stakeholders. Information collected included distance to health centers; health personnel; plants and trees used for traditional medicines; and household health situations. The next step is to discuss the findings with the sentinel landscape team with a view to developing some methodological tools for this component. Although many projects targeted household food security and nutrition, the data revealed that no project was executed specifically on health.

Summary of projects

The projects carried out in the sentinel landscape over the past 10 years were more concerned with the biophysical and socioeconomic components. A total of nine projects tackled one or more aspects related to soil surface characterization; vegetation assessment and measurement; soil sampling; soil texture; visible soil erosion; soil infiltration capacity; landform and land cover classification; and woody cover. The biophysical projects dominated the various interventions by different partners of the sentinel landscape. This was followed by socioeconomic projects with six interventions from the different stakeholders. Aspects such as the main livelihood activities; food consumption and composition; food scarcity; assets and incomes; food security; improved production; harvest and post-harvest techniques as well as the value chain of various products were examined by the partners. Although some aspects of health were studied in the landscape, no project was focused specifically on health. This aspect was neglected by the different stakeholders and partners.

4 Socioeconomic characteristics of households sampled in CAFHUT

This section builds on the exploratory analysis of Chiputwa et al. (2016), which summarized the main socioeconomic indicators into four broad categories: (i) household demographics; (ii) farm characteristics; (iii) farm dependency and income diversity; and (iv) household welfare, food security and nutrition. This analysis uses household data collected from 935 households across the four SL sites, as shown in Table 6. The households were randomly selected in accordance with the SL household sampling protocol[15] with slightly more than half of the respondents interviewed being female, in line with the CGIAR standards for collecting sex-disaggregated data.[16] Data used in this analysis are available on the CAFHUT SL dataverse page.[17]

Table 6. Summary statistics of sampled households by sentinel site

Sentinel site	Number of households interviewed	Gender represenatation of respondents (%)	
		Female	Male
Ediolomo (Bokito)	324	55.9	44.1
Ayos	275	41.5	58.5
Lomie-Kongo	202	46.5	53.5
Meyiboto (Mintom)	134	61.9	38.1
Total	**935**	**51.5**	**48.5**

Source: CAFHUT SL baseline data

15 http://www1.cifor.org/fileadmin/subsites/sentinel-landscapes/document/SL_Household_Module.pdf

16 http://www.pim.cgiar.org/files/2012/05/Standards-for-Collecting-Sex-Disaggregated-Data-for-Gender-Analysis.pdf

17 https://data.worldagroforestry.org/dataset.xhtml?persistentId=doi:10.34725/DVN/FNVTBD

4.1 Household demographics

This sub-section summarizes the demographics of sampled households disaggregated by site. Figure 3 shows that the average household size ranges from four to eight members across the four sites, with a median of six members for Ediomolo, seven for both Ayos and Lomie, and about eight Mintom. The Ayos SL site has the greatest number of outlier households, with 15 or more members.

Figure 4 shows the average off-farm labor demand by household across the four sites. Respondents were asked whether they usually hire off-farm labor for the production of cash and food crops. Ediolomo and Ayos have a lower proportion of households hiring labor, averaging 23% and 30% respectively, while the figures were 32% and 48% for Lomie and Mintom. As a result, there was an overall average of 30% hiring labor within the landscape.

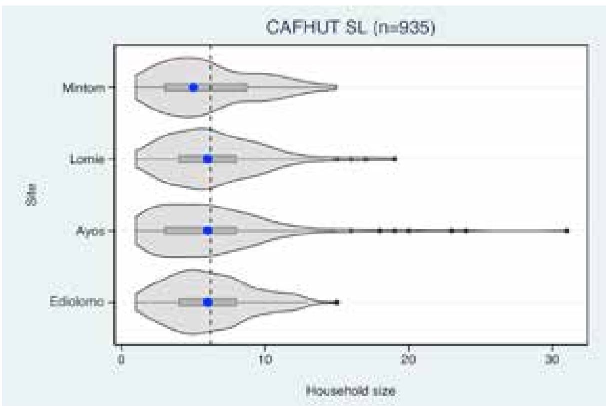

Figure 3. Household size

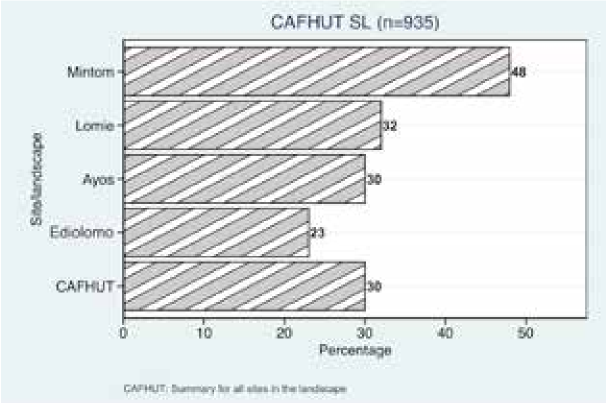

Figure 4. Off-farm labor demand

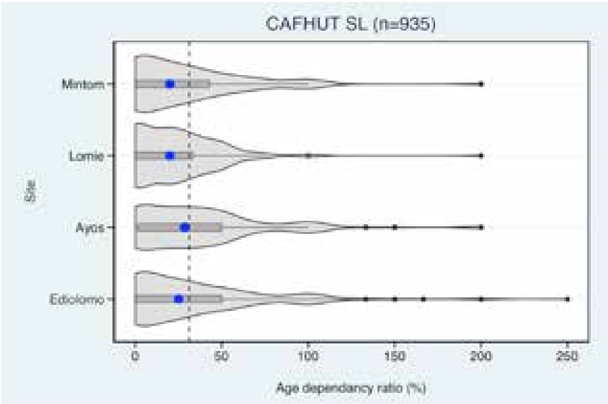

Figure 5. Age dependency ratio

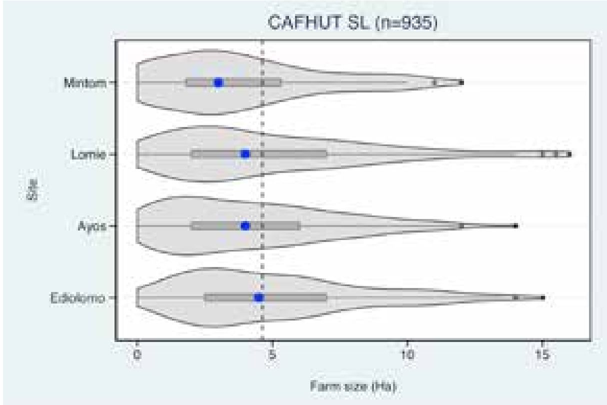

Figure 6. Farm size distribution

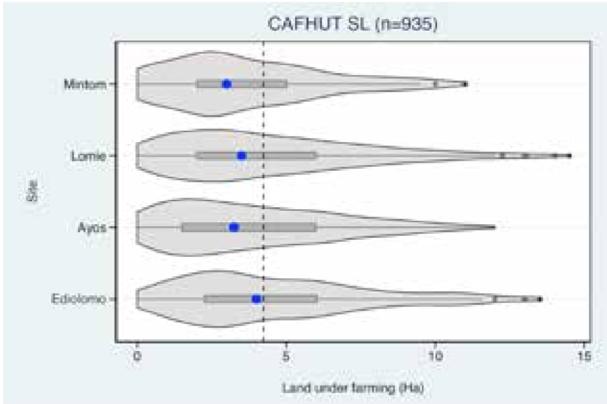

Figure 7. Area under cultivation

Figure 5 shows the Age Dependency Ratio (ADR) by site. The ADR is the ratio of people below 5 years of age and above 64 years old within a household compared with people aged from 5 to 64 years within the total population. While Ayos and Ediomolo have slightly higher median values, there is not much difference across the four sites.

4.2 Farm characteristics

This sub-section summarizes the farm characteristics of sampled households, disaggregated by site. Figure 6 shows the distribution of total farm land accessed, while Figure 7 shows the area under cultivation in hectares (ha). For both indicators, the median values are for areas of less than 5 ha, implying a typical smallholder farmer setting. Ediomolo has the highest median values for areas under cultivation (4.5 ha), followed by Ayos (4 ha), Lomie and Mintom (both with 3.5 ha).

Figure 8 shows the occurrence of trees on farms across sampled households by site. Respondents were asked three questions for each plot they have access to, indicating (i) whether they have trees on any of them; (ii) for those households with trees on their plots, whether they actively manage these trees (e.g. through trimming, pruning, weeding); and (iii) whether fruit trees are present. Of the 935 farmers surveyed, 44.4% (about 406 farmers) said at least one of their cultivated plots had trees on them. Out of the 406 farmers, 88% said they managed their trees, while 87% indicated that these trees included fruit species. It is important to note that the proportion of households with trees on farms, as presented in this paper, is a lower estimate as it only considers trees on arable land and not anywhere else on the farm (e.g. the homestead).

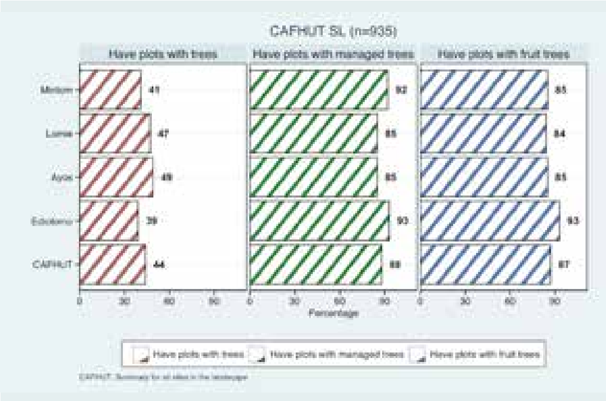

Figure 8. Trees on farms

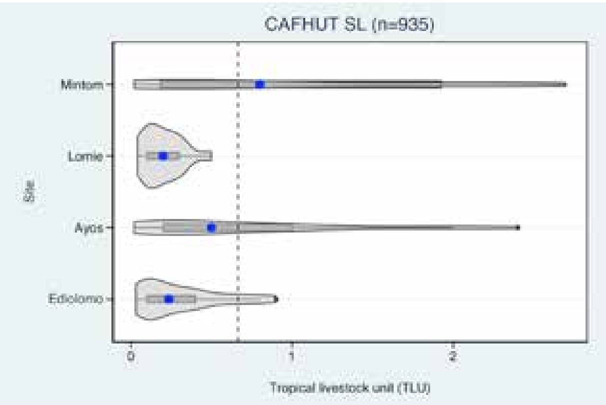

Figure 9. Tropical livestock unit (TLU)

Figure 9 shows the median Tropical Livestock Unit (TLU) across the four sites. The TLU is a common unit that describes livestock numbers across species to produce a single figure weighted according to the species type and age using the 'exchange ratio' concept (Njuki et al. 2011). The TLU distribution for households in Mintom is very different from the other three sites, suggesting that Mintom households have more livestock. The median TLU in Mintom is about 1 with an upper quartile range of about 3, while the median value for the other three sites is around 0.5 TLU or less.

Figure 10 shows the distribution of the household domestic asset index across the four sites. The domestic asset index aggregates ownership of all movable assets, including livestock (e.g. cattle, poultry, goats); household items (e.g. stove, radio, furniture); transport assets (e.g. car, motorcycle, cart);

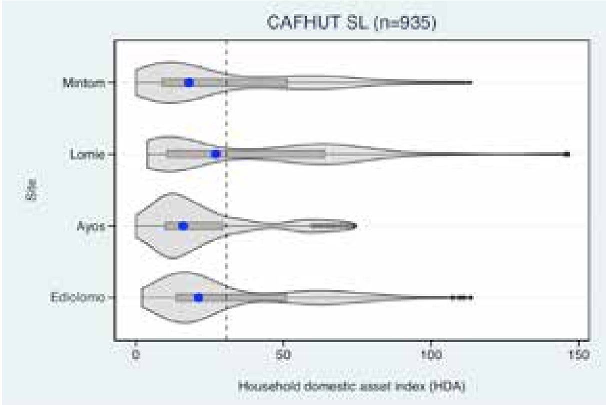

Figure 10. Household domestic asset index

and productive assets (e.g. hoes, ploughs, spades) into a single index. All assets are adjusted for quantity (number of each asset) and quality (age of each asset) before being assigned a corresponding weighted score. The results show that households in Ayos own more assets on average, followed by those in Lomie, Ediolomo and Mintom.

4.3 Farm dependency and income diversity

This sub-section compares the farm dependency and income diversity of sampled households across the four sites. There are several definitions that can be used for farm dependency. Here we adopt the definition of farm income as income from activities that are from the farmers' property. Non-farm income, on the other hand, includes income from activities that are outside the farmers' property, such as off-farm wages, business and fishing. We use information on household income from different sources to categorize income into the three categories shown in Table 7 and to compute measures of farm dependency.

We start with farm dependency, which is measured as the proportion of income coming from farm sources (i.e. income from the sale of crops, livestock and livestock products) compared with total household income, as presented in Figure 11. Households in Ediolomo have the highest dependency on farm income, followed by Ayos, Lomie and Mintom.

Table 7. Household farm dependency and income diversity

Off-farm income	On-farm income sources	Forest income
Business income	Sale of food crops	Sale of forest products
Wages or salaries (in cash)	Sale of livestock	
Other casual cash earnings	Sale of cash crops	
Cash remittances		
Selling local brew		
Fishing		
Rent received		
Pension received		
Government allowances		

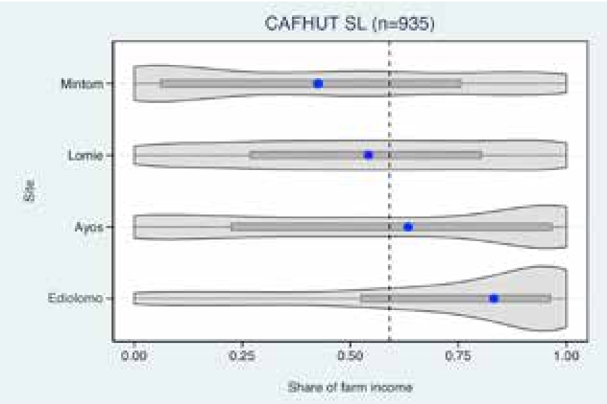

Figure 11. Contribution of farm activities to household income

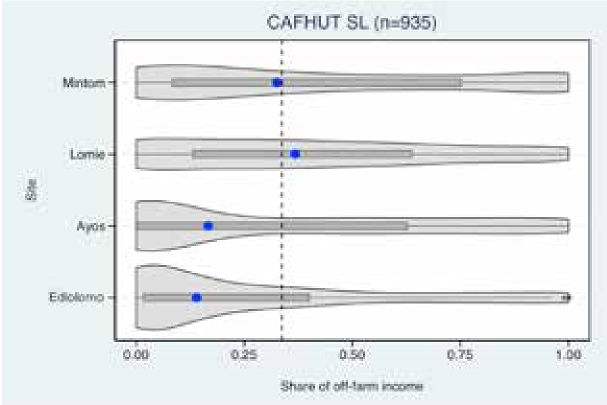

Figure 12. Contribution of non-farm activities to household income

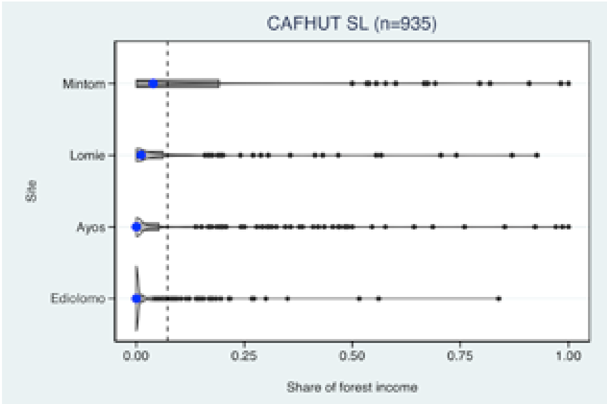

Figure 13. Contribution of forest amenities to household income

Figure 12 shows the contribution of non-farm activities to household income. Households sampled in Ediolomo have the lowest reliance on off-farm income compared with all the other sites.

The share or contribution of forest income is the proportion of income from the sale of forest products (e.g. charcoal, firewood, timber, honey, medicinal plants, wild fruits and insects) compared with total income, as presented in Figure 13. The plots show that there is generally very limited reliance on income from forest products. Most households sampled in Ediolomo do not generate any income from forest resources, while in Lomie the median income from forests is about 10%. A plausible explanation for such a low share could be that most amenities harvested from forests are for domestic consumption and hence are not traded in markets. Another explanation is the scarcitiy of forest resources as compared to other sites. Their use value is therefore not accounted for in this computation. (For an in-depth discussion on non-market value of trees on farms, see Chiputwa et al. 2020).

Figure 14 shows the degree of household dependency on (i) farm-only income, (ii) non-farm-only income, and (iii) mixed: both farm and non-farm income. The first category represents households that stated that all their household income was generated from the sale of crops, livestock and livestock products in the last 12 months.

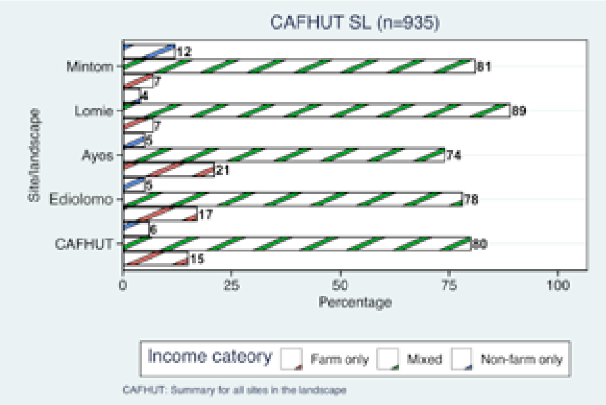

Figure 14. Household income composition

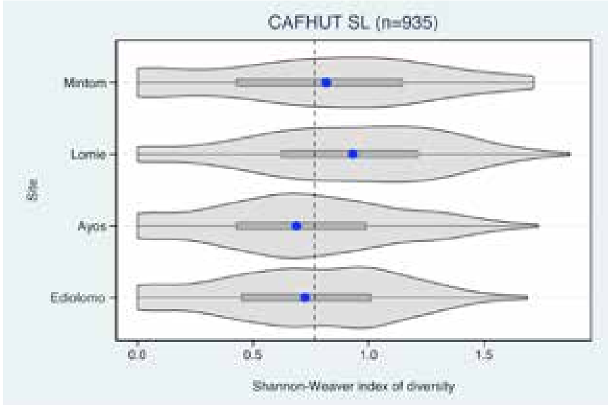

Figure 15. The Shannon-Weaver index of diversity

Ediolomo reported the highest proportion of households (24%) whose income comes entirely from farm production, followed by Mintom (18%), Lomie (8%) and Ayos (6%). The second category consists of households whose income comes exclusively from non-farm sources. Ayos has the highest proportion of households that rely on non-farm only income, due to a higher presence of elite groups as a consequence to the proximity to Yaoundé while Ediolomo has the least proportion, relying only on agriculture.

The third category is composed of households that rely on mixed income sources i.e. both farm and non-farm, and Ayos (89%) and Lomie (85%) have the most households in this category.

Income diversification, as used in this report, can be defined as the balance among different sources. Thus, by comparison, (i) a household with two different sources of income is more diversified than a household with just one source, and (ii) a household with two income sources, each contributing half of the total, would be more diversified than a household with two sources, one of which accounts for 90 percent of the total (Joshi et al. 2002; Minot et al. 2006). Figure 15 shows the Shannon-Weaver index of diversity also known as the Shannon-Wiener or the Shannon's diversity index. This index is, a measure of income diversity that takes into account both the number of income sources and their evenness. Households in Ayos have a relatively high median value for income diversity (1), followed by Lomie (0.9), Etolomo (0.7) and Mintom (0.6).

4.4 Household welfare, food security and nutrition

Households generally have varying degrees of wealth assets, which can be classified as physical capital (e.g. transport, livestock); human capital (household labor capacity); natural capital (land); financial capital (access to credit, remittances); and social capital (social support networks, such as group associations). Due to the differences in measurement scales, it is imperative to normalize/weight these assets in order to aggregate them into a single indicator that can be used to rank households according to wealth status. We use Principal Component Analysis, a technique that generates an overall index of wealth for each household. (For empirical applications, please refer to: Filmer and Pritchett 1998; Filmer and Pritchett 2001; Langyintuo and Mungoma 2008). Figure 16 shows the distribution of the livelihood resources index, also known as the wealth index. The Mintom SL site has the highest proportion of households (60%) that can be categorized as well endowed, followed by Ayos (50%), Ediolomo (47%) and Lomie (46%). It is important to note that these categories are computed for each site and can change when calculated for broader samples or units (e.g. at regional or national level).

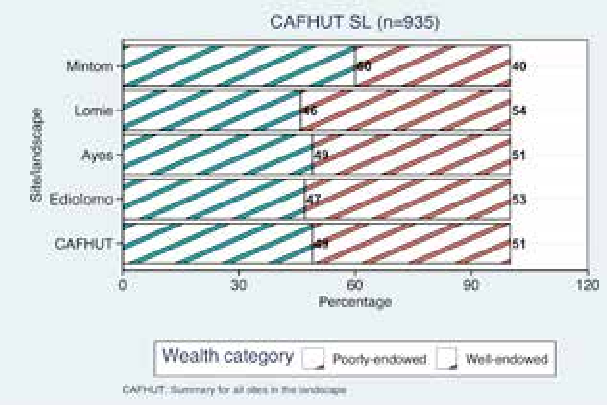

Figure 16. Livelihood resources index/ wealth index

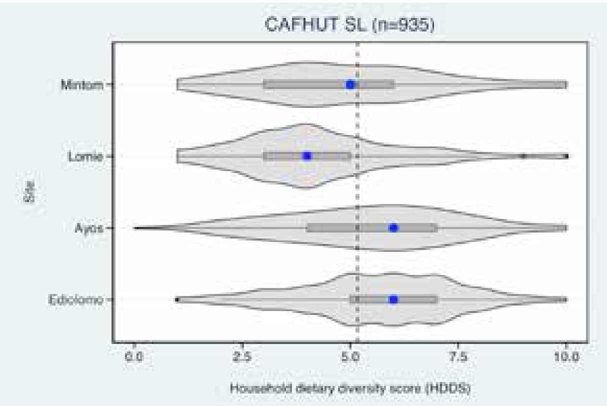

Figure 17. The Household Dietary Diversity Score (HDDS)

Figure 17 shows the Household Dietary Diversity Score (HDDS). This is a proxy for food security and nutrition because a more diversified diet is an important outcome, and is also correlated with factors such as calorie and protein adequacy, percentage of protein from animal source foods, and household incomes (Hoddinot and Yohannes 2002). Dietary diversity can be calculated for each household based on a food consumption module collected using 24-hour recall. The plot shows that Ediolomo and Ayos both have a median HDDS of 6 whle the Mintom site has a median value of 5 and Lomie has the least median value of 3.5.

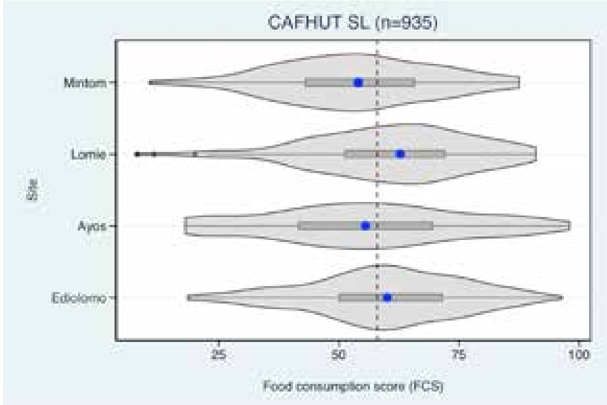

Figure 18. Food Consumption Score (FCS)

Figure 18 shows the the Food Consumption Score (FCS),[18] which is a weighted score used to assess households' access to food and its nutritional status. It is based on dietary diversity, food frequency and the nutritional importance of food groups consumed over a 7-day recall. FCS is measured as the sum of scores and ranges from 0 to 112. The upper value would be achieved if a household ate each food group every day over the last 7 days. The higher the food score, the more food-secure the household. There is not much difference in the FCS median values and variation between Ediolomo, Ayos and Mintom with median values between 50 and 60. Lomie on the hand has a median value below 50 and exhibits a mucher larger variation compared to the three other sites.

4.5 Partners involved and inventory of how stakeholders have worked in the landscape

The analysis here shows that there is a diversity of partners in the CAFHUT landscape working on diverse topics related to the main research questions being asked in the landscape. The preliminary work on the landscape was mainly conducted by FTA institutions (CIFOR, ICRAF, Bioversity International, CIRAD). In the early stages of work in CAFHUT, broader meetings were

18 For more detailed information, refer to https://www.wfp.org/publications/food-consumption-score-nutritional-quality-analysis-fcs-n-technical-guidance-note

organized with discussions and consultations with potential partners in the region. However, the final delineation of SL sites was determined mainly by FTA institutions. For the health work, IRD was involved due to its experience on the subject.

The analysis shows that the partners worked on a variety of subjects, depending on the projects and opportunities available to them. These projects were generally socioeconomic, biophysical and related to natural resource management. Additionally, most of the projects aimed to improve the livelihoods of the local population. The analysis showed that some partners were more present in some sites and therefore their activities dominate such areas. For example, it is well established that Ayos was one of the ASB sites in Cameroon, while Bokito had hosted many research activities by CIRAD, especially cocoa-related research. At least for those two sites, there is great potential for further research work.

An inventory of how stakeholders have worked in the landscape linked to FTA – regardless of whether it is linked to the SL – shows that many activities are taking place on the sites. Several research concept notes were developed by researchers of FTA institutions during the inception phases of SL site delineation. These may provide guidelines for future research activities in the four sites.

Thematic analysis shows that while may activities are carried out in the landscape, the probability of neglecting important subjects in some of the landscapes is high because not all partners are present in all the sites. This therefore requires concerted efforts and collaboration between the partners in the landscape so that the research topics and activities complement each other.

5 Lessons learned and major challenges from the projects executed in the landscape

5.1 Lessons learned

5.1.1 Socioeconomic projects

Increasing farmer revenue from NTFPs and the cultivation of agroforestry products

Such projects were aimed at ensuring the supply of quality products in enough quantities to meet consumer demand and to sustain growing NTFP/AFTP markets, without depleting the natural resource base. For example, after 4.5 years of project implementation in one case, it was found that vegetative propagation and on-farm cultivation of target species can effectively contribute to sustained quality production, thus improving value chains. However, many producers still collect trees/vines that grow spontaneously (especially for njansang, *Irvingia* and *Gnetum*), without any germplasm improvement and/or management. Some differences were noticed with regard to each of the target species, requiring appropriate and diversified strategies.

From such projects, it became evident that for farmers to reap the full benefits from most of the target NTFPs/AFTPs, more attention had to be paid to conservation, processing and packaging issues. The project therefore included a component on harvest and post-harvest technology. While some bottlenecks were solved during the project through research and experimentation – on the boiling/cracking of njansang, methods to combat weevil attack in kola, and the drying of safou – a lot still needs to be done to add value to NTFPs/AFTPs. On one project, a food technology consultant was hired to explore processing opportunities. This resulted in some useful insights, but further development in this domain would require teaming up with more specialized institutions and, if possible, the private sector.

Organizational mechanisms and arrangements

Projects addressing organizational mechanisms tested arrangements that allowed NTFP/AFTP producers to link up more efficiently with traders and the private sector. The ultimate objective was to improve the integration of poor farmers into NTFP/AFTP value chains. For this purpose, (i) the value chains of selected products were analyzed in order to identify actors, costs, benefits, opportunities and constraints related to marketing of the product; (ii) the capacity of producers and traders were strengthened so they can engage in collective action and link up with each other; and (iii) financial mechanisms were developed and tested to overcome some of the barriers that producers and traders face when seeking to increase their participation in value chains. It was concluded that much work still needs to be done to develop AFTP markets and products, and to increase the capacity of farmers and traders to develop sustainable enterprises around AFTPs. Furthermore, options to provide producers and traders with private-sector opportunities were considered useful in promoting growth in the sector.

The work on collective action and on other organizational mechanisms and arrangements has been commendable. Results from impact assessments have clearly demonstrated the positive effects of collective action on farmer livelihoods. However, such research has also raised questions that would need more in-depth social and anthropological studies in order to fully understand producers' behavior. This would help to scale the approach beyond project sites.

Policy and institutional analysis and arrangements

Projects analyzing the policy and institutional environment examined the constraints and opportunities that affect the integration of poor farmers into AFTP value chains. These factors included land and tree tenure arrangements, institutional mechanisms for exchange, power relations, and performance of the value chain. The empirical and theoretical arguments of studies suggest that policymakers need to design optimal sets of rules to match existing shifts in agricultural and conservation practices, whereby originally wild indigenous trees are now planted on farms. The studies recommend that rules be developed to encourage certain types of activities, specifically the adoption of agroforestry practices and forestry law compliance.

The studies have provided very useful insights as far as constraints and opportunities for agroforestry are concerned. It is therefore recommended that ICRAF team up with other organisations – such as CIFOR, FAO, IUCN or WWF – that have a mandate on the governance of forests and trees. This would help them to advocate for policy reforms based on scientific evidence regarding the role of NTFPs/AFTPs in economic development and poverty alleviation.

Developing community forest enterprises

Experience from the DRYAD project in Cameroon shows that:

- Most profitable enterprises participating in the scheme are not related timber, suggesting diversification away from timber;
- timber enterprises in community forests are unlikely to succeed without a joint enterprise approach;
- more investment in capacity building and institutional support might be required to de-risk community forests;
- community forests need help with expediting the procurement of official documents (e.g. permits, waybills) from local staff at the Ministry of Forests and Wildlife (MINFOF) and the Ministry of Environment, Nature Protection and Sustainable Development (MINEPDED) with regard to environmental impact notices.

Promoting sustainable agriculture (REDD+) project around Lobéké and Dzanga Ndoki national parks

We learned from such projects that:

- farmers can change their attitude if they are convinced of an innovation's efficiency;
- local partners (farmer organizations or NGOs) have an important role in identifying the appropriate participants/ actors for training that involves the development of their skills;
- minority indigenous groups (e.g. Bakka/ Bayaka) are willing to share their experience and adopt innovations, especially in areas where they aare reputation;more skilled
- farmers can contribute to the large-scale dissemination of accepted innovations, but they need to be properly mentored, when necessary;
- for short-term projects, germplasm support at the outset of the project is indispensable.

5.1.2 Biophysical

Reducing emissions from deforestation and forest degradation (REDD+) through alternative land uses in rainforests of the tropics

We learned from the above project that on a cocoa farm, the pool that stocks the highest quantity of carbon is made up of aboveground trees. These include timber trees, NTFPs and fruit trees. Timber trees play the most important role in carbon stocking, encompassing about 69% of the overall total carbon system. The stock of carbon in a cocoa agroforest largely depends on the management model. Cocoa yields increase with lower tree density values. To define a REDD+ strategy, it is necessary to take into account this trade-off and the possibility of orienting interventions toward conservation/ enrichment of systems with appropriate timber species in a suitable density. Cocoa farmers could exploit this option to increase their revenues and improve their livelihoods.

The following interventions can therefore be explored:

- For old cocoa farms, tree density should be regulated (thinning and distance control), considering the main role of big timber tree species as carbon pools.
- During the development of the system, enrich young cocoa farms with timber species that offer good potential to store carbon and, if necessary, eliminate some remnant trees in such a way that an optimal density is guaranteed.
- For new cocoa farms, selectively introduce associated species, preferably timber or fruit species and other NTFPs.

Moreover, to increase the yield of the cocoa agroforestry system and its productivity, the following key conditions should be considered:

- Promote cocoa farm intensification through high-quality seeds and the application of modern techniques (treatment with pesticides and fertilizers, and regular weeding).
- Facilitate accessibility and availability of these farm inputs.
- Provide farmers with effective knowledge on cocoa farming through capacity building.

The projects showed that the main success factor contributing to the results was technical support in the form of tree domestication and improvement techniques that were provided to cocoa farmers in one of the villages (Efoulan) as a non-financial incentive to intensify the cocoa agroforestry system.

We also find a few interesting lessons to be learned at different levels:

At community level:

- Provide fungicide to farmers tax-free
- The creation of recognisable, credible cooperative societies by rural farmers is imperative to facilitate the procurement of government financial assistance for engagement in sustainable intensification pathways.
- Capacity building of coorperative members on proper coorperative management

At resource level:

- Improve infrastructural resources such as roads
- Improve access to financial capital resources

5.2 Challenges

This subsection covers challenges described by some projects implemented in the landscape.

Agroforestry for Food Security (AFS4FOOD) project (2012–2015)

One of the major constraints in this area is the availability of labourers, usually coming from North-Western Cameroon or from Nigeria. All the cocoa farmers use paid workers for the management of their plots, and this area has a low population density. The farmers usually deal with intermediaries (often former labourers who settled down in the area) who bring new labourers from their place of origin and negotiate the contracts (oral or written). The work can be paid as a fixed salary or as a percentage of the revenue from cocoa sales. The latter option usually results in better management of the plot. Women play an important role in cocoa cultivation, more frequently in the process of pod breaking. They are currently organized as groups and are paid in cash for this task. Some of their groups also starting to get involved in other cocoa-related activities (e.g. plot cleaning). Because of the financial incentive of these tasks, women tend to give priority to this source of income at the expense of food-crop cultivation, especially during the last trimester of the year. On the other hand, women dedicate their time to food crops during the first half of the year, giving priority to crops such as groundnuts, cassavas, yams, maize and egusi, thus leading to a reduced labour force for cocoa.

Promoting sustainable agriculture (REDD+) project around Lobéké and Dzanga Ndoki national parks (2017–2018)

The following section describes challenges related to projects promoting sustainable agriculture in REDD+ projects around national parks:

- Training on income-generating activities was limited to trainers, who did not pass on these skills to intended beneficiaries for several reasons, such as poor project design:
  - Bee-keeping training in the REDD+ project ended at the training-of-trainers level because it wasn't recommended until the last implementation period, following requests by beneficiaries.
  - The project hosts were not well selected, leading to poor management and low participation of people.
- Project durations were often short, preventing the team from setting and following trials with good experimental design to assess performance through crop yields.
- There was high mobility for some indigenous groups, such as the Baka, especially when activities fell within the period of NTFP collection in the forest, making it difficult to reach target beneficiaries.
- Incursion of (wild and domestic) animals in demonstration plot may reduce the survival rate of plants.
- Insufficient participation and less motivation of group members in the project zone when it is a community farm, causing lack of confidence in the host.
- In some areas, farmers were reluctant to adopt cocoa plantations due to elephant attacks. Beehives were recommended in such cases to keep elephants away.
- Uncertainty of rain negatively affected the survival of plants in the demonstration plots of some villages.

5.3 Recommendations from projects

5.3.1 Recommendations/way forward in relation to afforestation of savanna with diversified cocoa-based agroforestry

The objectives of such projects are to protect the forest and create new resilient, multifunctional landscapes that provide social and economic benefits, and involve young generations. The focus was on the whole value chain from infrastructure development, access to land and market, creation and management of plantations, and development of youth entrepreneurship around the cocoa sector and other products. This included:

- identifying areas in the savanna transition zone for the development or improvement of roads and other necessary infrastructure, prioritizing options offering better market access;
- elaborating conditions with local authorities for farmers' access to land, taking into account the possible competition for cocoa and other land uses in the area;
- promoting climate-smart agricultural (CSA) practices for the creation and management of cocoa agroforestry plantations in savanna and neighbouring forest, as well as staple crops in savanna:
  - plan bush-fire control at the community level,
  - facilitate the creation of cocoa and tree nurseries (fruit and NTFP trees) in an entrepreneurial context,
  - provide cocoa varieties selected for their tolerance to drought and to low shade for plantation on savanna,
  - provide different designs for cocoa-tree spatial arrangements (cocoa-fruit, NTFP and timber trees, oil palm trees) and fertilization regimes,
  - testing the association of cocoa with nitrogen-fixing plants (trees and cover crops) to address low soil fertility, particularly at early planting stage,
  - testing shade buffers to address high temperatures and length of dry season in relation to water availability.

- improving the cocoa value chain (harvest, post-harvest and marketing) and promising agroforestry value chains; and
- setting up community-based facilities for training, demonstration, mutual learning, conflict resolution ('rural resource center' concept).

5.3.2 Recommendations from promoting sustainable agriculture (REDD+) project around national parks

The partners in the landscape must intervene in the following activities:

- Put in place appropriate strategies to follow benefit sharing within communities to avoid their dislocation.
- Continue following up community nurseries, as all groups are still strongly dependent.
- Ensure the growth of cocoa plantations already established. This will allow some groups to understand expected output: They have established a farm, but the concept of cocoa diversification (= increasing yield and diversification of revenue sources) is not yet mastered.
- Follow up the establishment of oil-palm plantations to avoid reverse effect. It is well known that oil-palm cultivation contributes to deforestation. Indeed, introducing cash crops in the area will help rehabilitate degraded land.
- Support communities with bee-farming start kits:
  - testing the effectiveness of bee farming in keeping away elephants
  - developing bee keeping as income-generating activities and exploring other possibilities, such as developing markets for agroforestry products.
- Improve governmental extension services (as a form of technical support) to communities.
- Legally recognize the customary ownership of trees planted on land, instead of them being the state's resource from a legal perspective.
- Government should improve community rights of access to resources by revising existing laws and policies governing tree planting on private land. For instance, one of the new proposals in the current forestry law reform suggests that all trees planted by an individual on private forest or land without an official land title should be the property of that individual and not that of the state.

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Annex A: Indicators – summary statistics tables

Table A1. Descriptive statistics of computed indicators 1

				Household size					Age dependency ratio					Household labor capacity			
	Site	Village	Sample size	N	Min	Max	Mean	SD	N	Min	Max	Mean	SD	Min	Max	Mean	SD
1	Ediolomo	Bakoa	33	33	1	12	6.00	2.50	33	0.00	250.00	39.13	58.46	0.90	7.80	4.09	1.74
2	Ediolomo	Batanga	31	31	1	12	6.00	2.90	29	0.00	200.00	44.82	48.89	0.80	8.80	4.22	2.12
3	Ediolomo	Bongando	31	31	1	15	7.00	3.30	30	0.00	100.00	28.13	24.11	0.80	10.20	4.95	2.41
4	Ediolomo	Bougnougoulouck	29	29	1	9	4.00	2.40	29	0.00	200.00	31.31	44.03	0.80	6.30	3.28	1.60
5	Ediolomo	Kedia	30	30	2	12	7.00	3.00	30	0.00	100.00	23.05	28.07	1.60	9.50	5.06	2.33
6	Ediolomo	Ossimb 1	33	33	1	13	6.00	3.10	33	0.00	150.00	42.07	35.58	0.80	8.40	4.12	2.06
7	Ediolomo	Tchekos	35	35	2	12	6.00	2.50	35	0.00	100.00	28.08	29.71	1.60	9.30	4.60	1.73
8	Ediolomo	Tobagne	30	30	1	15	6.00	3.30	30	0.00	100.00	30.37	35.26	0.80	11.20	4.85	2.63
9	Ediolomo	Yangben	39	39	2	12	6.00	3.00	37	0.00	166.67	35.17	37.95	1.60	10.20	4.64	2.28
10	Ediolomo	Yorro	33	33	1	13	7.00	3.00	33	0.00	133.33	29.36	35.86	0.00	10.20	4.88	2.42
11	Ayos	Abeng-nnam	29	29	1	20	7.00	4.40	28	0.00	100.00	34.76	30.04	1.00	16.20	5.13	3.26
12	Ayos	Bifos	24	24	2	31	8.00	7.20	24	0.00	100.00	27.09	26.71	1.70	21.40	5.59	5.19
13	Ayos	Mbang_2	29	29	1	10	4.00	2.60	26	0.00	133.33	28.21	37.87	0.80	8.20	3.24	1.85
14	Ayos	Mekouma	13	13	2	10	6.00	2.50	13	0.00	200.00	51.64	50.59	1.00	6.60	3.92	1.65
15	Ayos	Ndelle	34	34	1	12	6.00	3.20	33	0.00	200.00	42.45	43.16	0.80	9.90	4.30	2.26
16	Ayos	Ngoumesseng	33	33	1	20	7.00	4.00	32	0.00	100.00	35.12	32.11	0.80	14.20	4.78	2.80
17	Ayos	Niamvoudou	34	34	1	23	7.00	4.40	34	0.00	200.00	38.48	47.05	0.80	17.60	4.99	3.37
18	Ayos	Nkolmveng	15	15	4	13	7.00	2.90	15	0.00	150.00	42.71	43.69	2.00	9.90	4.89	2.25
19	Ayos	Nsan_ii	28	28	1	19	4.00	4.20	27	0.00	100.00	22.04	25.38	0.80	13.00	3.19	2.83
20	Ayos	Yebe	36	36	1	15	6.00	3.30	34	0.00	100.00	40.83	29.89	0.00	11.50	4.21	2.38
21	Lomie	Achip_2	18	18	3	15	6.00	3.50	18	0.00	66.67	29.89	23.16	2.30	10.40	4.49	2.35
22	Lomie	Doumzok_2	10	10	2	11	7.00	3.30	10	0.00	100.00	22.73	31.07	1.60	10.00	5.27	2.69
23	Lomie	Eschiambor	33	33	1	11	5.00	2.60	33	0.00	50.00	20.73	19.76	0.80	7.30	3.53	1.75
24	Lomie	Kongo	32	32	1	14	6.00	3.10	30	0.00	100.00	22.12	25.45	0.80	8.80	4.18	2.15
25	Lomie	Mayang	27	27	1	19	6.00	3.40	26	0.00	100.00	24.16	23.80	0.80	11.10	4.47	2.15
26	Lomie	Melene	9	9	2	17	7.00	4.60	9	0.00	25.00	10.47	10.60	1.90	11.90	4.99	3.13
27	Lomie	Moanguele_ bosquet	30	30	1	17	8.00	3.80	30	0.00	50.00	22.02	16.38	0.80	12.20	5.88	2.75
28	Lomie	Nemeyong_iii	9	9	1	9	5.00	2.30	8	0.00	75.00	22.32	24.87	0.80	6.40	3.70	1.57
29	Lomie	Ngola	34	34	1	19	7.00	3.40	34	0.00	200.00	29.65	36.92	0.80	13.90	4.99	2.42
30	Mintom	Akom	30	30	1	12	6.00	3.00	30	0.00	100.00	30.14	31.92	0.70	8.30	3.91	2.03
31	Mintom	Assok	7	7	3	12	7.00	3.60	7	0.00	50.00	20.77	19.47	2.30	8.90	4.99	2.41
32	Mintom	Bite	6	6	2	12	6.00	3.70	6	0.00	57.14	15.08	24.54	1.60	9.80	4.75	2.74
33	Mintom	Ekombitie	20	20	1	14	6.00	3.90	19	0.00	50.00	14.97	16.33	0.80	10.10	4.35	2.78
34	Mintom	Lele	28	28	2	15	8.00	3.80	28	0.00	200.00	38.71	38.94	1.80	11.60	5.08	2.65
35	Mintom	Mboutoukong	16	16	1	11	5.00	2.60	15	0.00	100.00	26.67	33.10	0.80	8.20	3.48	2.10
36	Mintom	Nkolfong	15	15	2	13	6.00	2.90	15	0.00	100.00	26.06	38.08	0.00	8.50	3.81	1.94
37	Mintom	Nkolkoumou	12	12	2	10	6.00	2.80	12	0.00	100.00	42.51	38.51	1.00	7.20	4.26	2.22

Table A2. Descriptive statistics of computed indicators 2

				Farm size (Ha)				Number of plots					Farm under cultivation (Ha)				
Site	Village	Sample size	N	Min	Max	Mean	SD	N	Min	Max	Mean	SD	N	Min	Max	Mean	SD
1 Ediolomo	Bakoa	33	33	0.56	21.00	4.35	3.85	33	1	5	3.00	1.22	33	0.56	11.00	3.82	2.45
2 Ediolomo	Batanga	31	31	0.75	11.00	5.05	2.80	31	1	5	3.00	0.92	31	0.75	11.00	5.05	2.80
3 Ediolomo	Bongando	31	31	0.10	13.50	5.19	3.66	31	1	5	3.00	1.06	31	0.10	13.50	4.90	3.38
4 Ediolomo	Bougnougoulouck	29	29	1.00	20.50	8.60	5.37	29	1	5	3.00	1.41	29	1.00	15.50	7.08	4.21
5 Ediolomo	Kedia	30	30	1.00	18.00	5.68	3.81	30	1	3	2.00	0.74	30	1.00	12.00	5.22	3.11
6 Ediolomo	Ossimb 1	33	33	0.50	20.00	7.26	3.87	33	1	5	3.00	1.01	33	0.00	16.00	6.55	3.24
7 Ediolomo	Tchekos	35	35	1.00	45.50	7.79	8.24	35	1	5	3.00	1.30	35	1.00	45.50	7.44	8.39
8 Ediolomo	Tobagne	30	30	0.50	27.00	8.77	6.86	30	1	5	3.00	1.23	30	0.50	24.00	6.64	5.21
9 Ediolomo	Yangben	39	39	0.20	33.00	3.76	5.42	39	1	5	2.00	0.93	39	0.00	8.00	2.25	1.67
10 Ediolomo	Yorro	33	33	0.04	42.00	6.05	7.49	33	1	5	2.00	1.12	33	0.04	42.00	5.91	7.52
11 Ayos	Abeng-nnam	29	29	0.15	300.78	16.34	55.56	29	1	7	3.00	1.38	29	0.15	300.78	15.67	55.62
12 Ayos	Bifos	24	24	0.40	55.00	10.45	14.45	24	1	6	3.00	1.18	24	0.40	30.00	6.14	6.07
13 Ayos	Mbang_2	29	29	0.02	40.00	6.77	8.53	29	1	6	3.00	1.23	29	0.02	40.00	4.80	7.37
14 Ayos	Mekouma	13	13	0.37	52.00	10.96	13.81	13	1	10	3.00	2.18	13	0.37	12.00	4.96	3.25
15 Ayos	Ndelle	34	34	0.04	4500.51	138.58	770.76	34	1	7	3.00	1.58	34	0.04	4500.51	137.11	771.01
16 Ayos	Ngoumesseng	33	33	0.50	153.50	11.44	26.91	33	1	7	4.00	1.35	33	0.50	153.50	11.27	26.94
17 Ayos	Niamvoudou	34	34	0.50	25.50	6.28	5.44	34	2	7	4.00	1.35	34	0.50	12.00	4.99	2.95
18 Ayos	Nkolmveng	15	15	1.28	34.50	8.85	8.60	15	2	7	3.00	1.50	15	1.28	14.50	5.45	4.06
19 Ayos	Nsan_ii	28	28	0.75	86.25	10.76	17.52	28	1	10	3.00	1.93	28	0.00	17.50	5.26	3.98
20 Ayos	Yebe	36	36	0.08	25.00	4.98	4.68	36	1	9	3.00	1.55	36	0.08	8.50	3.75	2.43
21 Lomie	Achip_2	18	18	1.50	8.00	4.42	2.08	18	1	5	3.00	1.03	18	1.50	7.56	3.64	1.79
22 Lomie	Doumzok_2	10	10	0.01	504.51	55.21	157.97	10	2	6	3.00	1.32	10	0.01	504.51	53.71	158.42
23 Lomie	Eschiambor	33	33	0.51	51.55	5.96	8.66	33	1	4	3.00	0.71	33	0.05	51.55	5.35	8.72
24 Lomie	Kongo	32	31	0.04	16.50	5.22	3.77	31	1	6	2.00	1.17	31	0.00	16.50	4.67	3.62
25 Lomie	Mayang	27	26	0.10	8.25	4.96	2.39	26	1	6	3.00	1.15	26	0.10	8.25	4.37	2.32
26 Lomie	Melene	9	9	0.00	7.00	2.73	2.43	9	1	5	3.00	1.58	9	0.00	7.00	2.62	2.33
27 Lomie	Moanguele_ bosquet	30	30	0.10	21.50	3.75	4.95	30	1	4	2.00	0.97	30	0.10	6.50	2.18	1.89
28 Lomie	Nemeyong_iii	9	9	0.50	11.00	5.17	3.88	9	1	4	3.00	1.09	9	0.50	9.00	4.11	2.72
29 Lomie	Ngola	34	34	0.09	19.00	4.71	4.47	34	1	6	3.00	1.16	34	0.09	19.00	4.31	4.07
30 Mintom	Akom	30	29	0.10	121.95	9.08	22.21	29	1	5	3.00	1.37	29	0.10	121.95	9.08	22.21
31 Mintom	Assok	7	7	0.08	17.00	3.78	5.89	7	1	3	2.00	0.69	7	0.08	17.00	3.78	5.89
32 Mintom	Bite	6	6	0.75	100.50	20.30	39.50	6	1	5	2.00	1.51	6	0.00	12.00	3.13	4.60
33 Mintom	Ekombitie	20	20	0.00	10.00	3.75	2.92	20	1	3	1.00	0.60	20	0.00	10.00	3.75	2.92
34 Mintom	Lele	28	28	0.01	50.00	4.68	9.39	28	1	5	2.00	1.29	28	0.00	50.00	4.51	9.31
35 Mintom	Mboutoukong	16	14	0.50	25.00	7.02	8.03	14	1	4	2.00	1.09	14	0.50	25.00	6.95	8.00
36 Mintom	Nkolfong	15	15	0.09	16.00	4.41	3.99	15	1	5	3.00	1.62	15	0.09	16.00	4.35	4.00
37 Mintom	Nkolkoumou	12	12	0.00	2700.00	229.28	778.10	12	1	2	2.00	0.52	12	0.00	2700.00	229.28	778.10

Table A3. Descriptive statistics of computed indicators 3

					Tropical livestock unit (TLU)				Household domestic asset index (HDA)			
	Site	Village	Sample size	N	Min	Max	Mean	SD	Min	Max	Mean	SD
1	Ediolomo	Bakoa	33	4	0.30	0.70	0.48	0.17	8.40	110.90	30.19	26.01
2	Ediolomo	Batanga	31	0					2.60	80.50	22.04	16.88
3	Ediolomo	Bongando	31	2	0.30	0.90	0.60	0.42	8.60	208.40	40.08	44.53
4	Ediolomo	Bougnougoulouck	29	1	0.60	0.60	0.60		12.40	149.00	42.05	31.26
5	Ediolomo	Kedia	30	3	0.10	0.43	0.24	0.17	6.60	79.60	26.09	15.48
6	Ediolomo	Ossimb 1	33	6	0.10	0.90	0.24	0.33	7.10	243.40	35.87	43.59
7	Ediolomo	Tchekos	35	5	0.10	2.30	0.74	0.89	6.60	241.60	50.32	49.58
8	Ediolomo	Tobagne	30	0					6.20	224.10	34.94	41.02
9	Ediolomo	Yangben	39	4	0.10	0.70	0.32	0.26	3.60	107.40	24.48	20.47
10	Ediolomo	Yorro	33	5	0.07	0.75	0.50	0.27	6.00	104.20	30.59	23.64
11	Ayos	Abeng-nnam	29	7	0.04	0.80	0.29	0.27	5.60	194.00	41.73	45.49
12	Ayos	Bifos	24	4	0.15	2.50	1.11	1.14	4.00	139.50	55.45	35.71
13	Ayos	Mbang_2	29	2	0.10	0.40	0.25	0.21	5.40	82.40	30.16	26.83
14	Ayos	Mekouma	13	1	0.80	0.80	0.80		7.80	242.60	71.97	59.64
15	Ayos	Ndelle	34	2	0.10	0.10	0.10	0.00	4.30	201.20	43.55	45.64
16	Ayos	Ngoumesseng	33	6	0.10	7.80	1.47	3.10	3.80	185.80	43.67	41.51
17	Ayos	Niamvoudou	34	2	0.30	0.40	0.35	0.07	8.20	189.20	58.67	49.07
18	Ayos	Nkolmveng	15	2	0.03	0.40	0.22	0.26	5.60	100.60	41.31	34.67
19	Ayos	Nsan_ii	28	4	0.05	0.20	0.13	0.06	4.80	81.60	29.71	27.03
20	Ayos	Yebe	36	3	0.08	0.30	0.16	0.12	5.20	109.30	40.79	29.55
21	Lomie	Achip_2	18	4	0.30	2.00	1.07	0.70	8.00	125.00	35.71	29.89
22	Lomie	Doumzok_2	10	2	0.02	60.00	30.01	42.41	6.40	6018.90	623.19	1895.98
23	Lomie	Eschiambor	33	3	0.20	3.00	1.70	1.41	5.60	86.50	34.23	27.57
24	Lomie	Kongo	32	5	0.20	25.00	5.76	10.78	5.00	310.00	48.33	58.26
25	Lomie	Mayang	27	3	0.13	20.00	6.79	11.44	7.20	2016.80	107.98	382.44
26	Lomie	Melene	9	0					8.90	59.60	26.13	20.93
27	Lomie	Moanguele_bosquet	30	6	0.90	6.00	1.90	2.02	4.00	95.40	23.18	25.45
28	Lomie	Nemeyong_iii	9	3	0.10	35000.00	11667.37	20206.65	5.20	350102.40	38939.17	116686.22
29	Lomie	Ngola	34	11	0.04	3.42	1.81	1.18	3.00	147.80	45.53	43.20
30	Mintom	Akom	30	0					0.00	55.80	6.10	12.24
31	Mintom	Assok	7	1	0.03	0.03	0.03		0.80	10.00	6.47	3.10
32	Mintom	Bite	6	0					3.60	13.40	8.82	4.35
33	Mintom	Ekombitie	20	1	0.10	0.10	0.10		2.00	205.40	29.02	45.45
34	Mintom	Lele	28	3	0.02	0.20	0.12	0.09	3.70	77.20	29.11	24.15
35	Mintom	Mboutoukong	16	4	0.12	212.00	53.26	105.83	5.40	2183.40	198.11	538.70
36	Mintom	Nkolfong	15	0					5.60	220.80	54.49	62.66
37	Mintom	Nkolkoumou	12	0					0.00	44.40	10.17	13.46

Table A4. Descriptive statistics of computed indicators 4

				Male domestic asset index					Female domestic asset index					Joint domestic asset index					Gender asset disparity index			
	Site	Village	Sample size	N	Min	Max	Mean	SD	N	Min	Max	Mean	SD	N	Min	Max	Mean	SD	Min	Max	Mean	SD
1	Ediolomo	Bakoa	33	33	0.00	1.00	0.38	0.31	33	0.00	1.00	0.27	0.25	33	0.00	0.89	0.36	0.27	0.00	Inf	Inf	Inf
2	Ediolomo	Batanga	31	31	0.00	0.86	0.46	0.24	31	0.00	1.00	0.27	0.25	31	0.00	1.00	0.28	0.23	0.04	Inf	Inf	Inf
3	Ediolomo	Bongando	31	31	0.00	1.00	0.46	0.29	31	0.00	0.88	0.21	0.20	31	0.00	0.85	0.33	0.24	0.00	Inf	Inf	Inf
4	Ediolomo	Bougnougoulouck	29	29	0.00	1.00	0.60	0.29	29	0.00	0.78	0.17	0.17	29	0.00	0.84	0.23	0.21	0.00	Inf	Inf	Inf
5	Ediolomo	Kedia	30	30	0.00	0.87	0.40	0.25	30	0.00	1.00	0.25	0.24	30	0.00	0.91	0.36	0.23	0.00	Inf	Inf	Inf
6	Ediolomo	Ossimb 1	33	33	0.00	1.00	0.47	0.32	33	0.00	1.00	0.27	0.26	33	0.00	1.00	0.26	0.27	0.00	Inf	Inf	Inf
7	Ediolomo	Tchekos	35	35	0.00	0.96	0.59	0.25	35	0.00	0.70	0.22	0.19	35	0.00	0.62	0.20	0.18	0.00	Inf	Inf	Inf
8	Ediolomo	Tobagne	30	30	0.00	1.00	0.50	0.27	30	0.00	0.85	0.22	0.19	30	0.00	0.86	0.29	0.20	0.00	Inf	Inf	Inf
9	Ediolomo	Yangben	39	39	0.00	0.97	0.35	0.31	39	0.00	1.00	0.28	0.26	39	0.00	1.00	0.37	0.24	0.00	Inf	Inf	Inf
10	Ediolomo	Yorro	33	33	0.00	0.90	0.32	0.29	33	0.00	1.00	0.28	0.28	33	0.00	0.96	0.40	0.24	0.00	Inf	Inf	Inf
11	Ayos	Abeng-nnam	29	29	0.00	1.00	0.43	0.35	29	0.00	0.88	0.20	0.25	29	0.00	1.00	0.37	0.32	0.00	Inf	Inf	Inf
12	Ayos	Bifos	24	24	0.00	0.90	0.55	0.34	24	0.00	1.00	0.20	0.30	24	0.00	0.93	0.26	0.28	0.00	Inf	Inf	Inf
13	Ayos	Mbang_2	29	29	0.00	1.00	0.41	0.37	29	0.00	1.00	0.23	0.34	29	0.00	1.00	0.36	0.35	0.00	Inf	Inf	Inf
14	Ayos	Mekouma	13	13	0.01	0.89	0.44	0.36	13	0.00	0.22	0.07	0.06	13	0.01	0.98	0.48	0.37	0.00	2.64	0.61	0.80
15	Ayos	Ndelle	34	34	0.00	1.00	0.52	0.34	34	0.00	0.86	0.19	0.22	34	0.00	1.00	0.29	0.26	0.00	Inf	Inf	Inf
16	Ayos	Ngoumesseng	33	33	0.00	1.00	0.52	0.36	33	0.00	1.00	0.19	0.26	33	0.00	0.82	0.30	0.27	0.00	Inf	Inf	Inf
17	Ayos	Niamvoudou	34	34	0.00	0.97	0.42	0.31	34	0.00	0.98	0.18	0.27	34	0.00	1.00	0.40	0.29	0.00	56.95	3.45	10.61
18	Ayos	Nkolmveng	15	15	0.00	0.87	0.53	0.31	15	0.00	0.87	0.28	0.29	15	0.00	0.56	0.19	0.18	0.00	Inf	Inf	Inf
19	Ayos	Nsan_ii	28	28	0.00	1.00	0.41	0.35	28	0.00	1.00	0.18	0.27	28	0.00	1.00	0.41	0.32	0.00	Inf	Inf	Inf
20	Ayos	Yebe	36	36	0.00	1.00	0.53	0.36	36	0.00	1.00	0.16	0.23	36	0.00	0.85	0.31	0.29	0.00	Inf	Inf	Inf
21	Lomie	Achip_2	18	18	0.00	0.98	0.48	0.35	18	0.02	1.00	0.22	0.28	18	0.00	0.88	0.30	0.26	0.02	Inf	Inf	Inf
22	Lomie	Doumzok_2	10	10	0.00	1.00	0.44	0.35	10	0.00	1.00	0.23	0.30	10	0.00	0.70	0.33	0.29	0.00	4139.97	414.66	1308.94
23	Lomie	Eschiambor	33	33	0.00	1.00	0.41	0.36	33	0.00	0.93	0.26	0.27	33	0.00	1.00	0.33	0.28	0.00	Inf	Inf	Inf
24	Lomie	Kongo	32	32	0.00	1.00	0.46	0.37	32	0.00	1.00	0.26	0.33	32	0.00	1.00	0.28	0.28	0.00	Inf	Inf	Inf
25	Lomie	Mayang	27	27	0.00	1.00	0.51	0.34	27	0.00	1.00	0.14	0.20	27	0.00	0.90	0.35	0.33	0.00	Inf	Inf	Inf
26	Lomie	Melene	9	9	0.06	0.86	0.47	0.33	9	0.00	0.46	0.15	0.18	9	0.12	0.92	0.39	0.29	0.00	7.39	1.53	2.87
27	Lomie	Moanguele_ bosquet	30	30	0.00	1.00	0.31	0.32	30	0.00	0.68	0.22	0.22	30	0.00	1.00	0.47	0.34	0.00	Inf	Inf	Inf
28	Lomie	Nemeyong_iii	9	9	0.00	0.76	0.31	0.35	9	0.02	1.00	0.37	0.39	9	0.00	0.92	0.31	0.30	0.04	Inf	Inf	Inf
29	Lomie	Ngola	34	34	0.00	1.00	0.47	0.32	34	0.00	0.75	0.16	0.20	34	0.00	1.00	0.38	0.31	0.00	Inf	Inf	Inf
30	Mintom	Akom	30	12	0.00	1.00	0.47	0.29	12	0.00	0.39	0.15	0.14	12	0.00	0.75	0.39	0.25	0.00	Inf	Inf	Inf
31	Mintom	Assok	7	7	0.00	0.79	0.42	0.32	7	0.07	0.82	0.37	0.29	7	0.00	0.60	0.22	0.22	0.09	Inf	Inf	Inf
32	Mintom	Bite	6	6	0.00	0.52	0.23	0.20	6	0.00	0.20	0.13	0.08	6	0.31	1.00	0.63	0.25	0.31	2.11	0.92	0.78
33	Mintom	Ekombitie	20	20	0.00	1.00	0.51	0.38	20	0.00	1.00	0.19	0.24	20	0.00	0.92	0.28	0.29	0.00	Inf	Inf	Inf
34	Mintom	Lele	28	28	0.00	1.00	0.54	0.32	28	0.00	1.00	0.17	0.21	28	0.00	0.84	0.29	0.24	0.00	Inf	Inf	Inf
35	Mintom	Mboutoukong	16	16	0.00	1.00	0.60	0.43	16	0.00	1.00	0.12	0.24	16	0.00	0.94	0.22	0.34	0.00	Inf	Inf	Inf
36	Mintom	Nkolfong	15	15	0.00	1.00	0.65	0.33	15	0.00	0.96	0.18	0.26	15	0.00	0.64	0.17	0.21	0.00	Inf	Inf	Inf
37	Mintom	Nkolkoumou	12	10	0.00	1.00	0.45	0.44	10	0.00	0.19	0.07	0.08	10	0.00	1.00	0.48	0.44	0.00	Inf	Inf	Inf

Table A5. Descriptive statistics of computed indicators 5

	Site	Village	Sample size	Gross crop production income					Farm income share					Off-farm income share					Forest income share				
				N	Min	Max	Mean	SD	N	Min	Max	Mean	SD	N	Min	Max	Mean	SD	N	Min	Max	Mean	SD
1	Ediolomo	Bakoa	33	33	1286.00	209609.00	44800.48	55731.95	33	0.16	1.00	0.74	0.24	28	0.02	0.73	0.28	0.22	11	0.01	0.18	0.07	0.07
2	Ediolomo	Batanga	31	31	35.00	906916.00	63787.87	163490.81	31	0.22	1.00	0.85	0.18	23	0.02	0.78	0.18	0.19	11	0.00	0.12	0.03	0.03
3	Ediolomo	Bongando	31	31	672.00	142506.00	37833.03	37587.86	31	0.13	1.00	0.82	0.24	20	0.03	0.87	0.28	0.25	5	0.00	0.05	0.02	0.03
4	Ediolomo	Bougnougoulouck	29	29	323.00	618707.00	65485.28	121770.56	28	0.29	1.00	0.85	0.19	21	0.03	1.00	0.23	0.26	7	0.00	0.14	0.05	0.05
5	Ediolomo	Kedia	30	30	1962.00	1572384.00	144178.93	345652.22	29	0.13	1.00	0.82	0.25	17	0.02	1.00	0.35	0.31	3	0.00	0.19	0.07	0.10
6	Ediolomo	Ossimb 1	33	33	1.00	1783510.00	141394.82	338046.78	32	0.11	1.00	0.78	0.26	25	0.00	1.00	0.23	0.29	15	0.01	0.84	0.14	0.24
7	Ediolomo	Tchekos	35	35	770.00	1578977.00	91911.97	270576.58	35	0.11	1.00	0.81	0.23	25	0.01	0.89	0.26	0.24	11	0.00	0.06	0.02	0.02
8	Ediolomo	Tobagne	30	30	232.00	244874.00	46389.27	59866.71	30	0.04	1.00	0.78	0.25	25	0.01	0.96	0.26	0.26	7	0.00	0.04	0.02	0.02
9	Ediolomo	Yangben	39	36	3.00	241831.00	23818.06	48660.08	34	0.03	1.00	0.79	0.30	25	0.01	1.00	0.47	0.39	8	0.00	0.15	0.03	0.05
10	Ediolomo	Yorro	33	33	403.00	215138.00	37681.58	51196.55	33	0.01	1.00	0.75	0.29	21	0.00	0.98	0.38	0.29	6	0.00	0.07	0.03	0.02
11	Ayos	Abeng-nnam	29	29	820.00	98400973.00	4004490.69	18178893.59	27	0.11	1.00	0.62	0.28	24	0.02	1.00	0.44	0.27	20	0.00	0.11	0.04	0.03
12	Ayos	Bifos	24	24	16162.00	5745885.00	1310964.46	1537269.83	24	0.08	1.00	0.70	0.27	18	0.03	0.92	0.34	0.25	17	0.01	0.20	0.06	0.05
13	Ayos	Mbang_2	29	29	672.00	3183707.00	592026.90	651553.18	29	0.07	1.00	0.61	0.30	25	0.05	0.93	0.41	0.29	10	0.01	0.41	0.10	0.12
14	Ayos	Mekouma	13	13	60608.00	1360777.00	489052.38	442730.13	13	0.03	1.00	0.50	0.35	10	0.05	0.84	0.50	0.28	10	0.00	0.57	0.15	0.18
15	Ayos	Ndelle	34	34	496.00	700072170.00	21243662.82	119948190.36	29	0.03	1.00	0.51	0.28	33	0.03	1.00	0.53	0.31	16	0.00	0.87	0.10	0.21
16	Ayos	Ngoumesseng	33	33	8191.00	2082765.00	446626.48	463086.67	33	0.02	1.00	0.55	0.29	26	0.01	0.98	0.37	0.23	27	0.01	0.93	0.19	0.24
17	Ayos	Niamvoudou	34	34	544.00	15203362.00	1245238.21	2673668.42	31	0.04	1.00	0.57	0.31	30	0.03	1.00	0.49	0.31	18	0.01	0.19	0.04	0.05
18	Ayos	Nkolmveng	15	15	1453.00	2566206.00	449769.67	627736.47	14	0.11	0.99	0.56	0.24	14	0.01	1.00	0.46	0.27	7	0.01	0.35	0.09	0.12
19	Ayos	Nsan_ii	28	28	1103.00	5875947.00	641156.00	1130675.14	26	0.06	1.00	0.59	0.31	25	0.00	1.00	0.43	0.34	19	0.01	0.43	0.10	0.11
20	Ayos	Yebe	36	36	736.00	1243721.00	398709.64	347424.81	33	0.03	1.00	0.49	0.31	33	0.07	1.00	0.55	0.32	22	0.00	0.30	0.08	0.09
21	Lomie	Achip_2	18	18	24000.00	12093000.00	1185092.78	2766421.20	16	0.05	1.00	0.49	0.34	16	0.03	1.00	0.56	0.32	10	0.00	0.60	0.12	0.18
22	Lomie	Doumzok_2	10	9	28000.00	624000.00	338416.67	248186.61	8	0.04	1.00	0.56	0.37	9	0.04	1.00	0.55	0.40	7	0.01	0.20	0.08	0.07
23	Lomie	Eschiambor	33	33	10000.00	6065000.00	1072162.88	1488332.86	32	0.06	1.00	0.50	0.33	25	0.04	0.93	0.50	0.33	23	0.01	1.00	0.20	0.26
24	Lomie	Kongo	32	29	2900.00	9402500.00	1101807.48	1874520.27	26	0.06	1.00	0.62	0.31	25	0.01	1.00	0.41	0.34	25	0.00	0.79	0.23	0.20
25	Lomie	Mayang	27	26	4800.00	50473000.00	3122620.54	9711813.82	25	0.01	1.00	0.58	0.38	20	0.03	1.00	0.52	0.35	16	0.00	0.67	0.13	0.21
26	Lomie	Melene	9	7	42000.00	600000.00	265252.86	213832.34	6	0.02	0.88	0.30	0.30	8	0.12	1.00	0.65	0.40	4	0.06	0.67	0.49	0.29
27	Lomie	Moanguele_ bosquet	30	27	5000.00	3828000.00	762469.63	889721.34	25	0.02	0.90	0.35	0.28	29	0.03	1.00	0.42	0.32	27	0.01	0.82	0.34	0.26
28	Lomie	Nemeyong_iii	9	9	85750.00	4936000.00	890133.33	1557005.07	8	0.21	1.00	0.61	0.30	8	0.04	1.00	0.47	0.33	4	0.02	0.18	0.10	0.07
29	Lomie	Ngola	34	34	5000.00	10950000.00	1227929.00	2333895.47	30	0.09	1.00	0.56	0.28	27	0.13	1.00	0.53	0.27	26	0.01	0.31	0.12	0.09
30	Mintom	Akom	30	29	2.00	66920.00	8694.66	16975.76	24	0.14	1.00	0.79	0.30	13	0.03	1.00	0.58	0.35	5	0.03	1.00	0.30	0.42
31	Mintom	Assok	7	7	64.00	182021.00	42573.71	67067.73	4	0.00	0.55	0.22	0.26	6	0.01	1.00	0.63	0.44	4	0.06	1.00	0.58	0.49
32	Mintom	Bite	6	6	99.00	75314.00	13155.67	30463.13	6	0.22	1.00	0.77	0.31	3	0.21	0.78	0.46	0.29	0				
33	Mintom	Ekombitie	20	20	1.00	82503.00	15365.30	26280.20	15	0.04	1.00	0.59	0.37	15	0.03	1.00	0.62	0.36	5	0.02	0.22	0.15	0.08
34	Mintom	Lele	28	27	2.00	1003818.00	99092.07	265032.26	18	0.09	1.00	0.49	0.33	24	0.01	1.00	0.57	0.37	9	0.20	1.00	0.61	0.35
35	Mintom	Mboutoukong	16	15	12.00	310278.00	71383.00	105505.43	11	0.14	1.00	0.53	0.29	15	0.00	1.00	0.48	0.38	8	0.02	0.69	0.36	0.27
36	Mintom	Nkolfong	15	15	3.00	288502.00	33448.33	72396.37	11	0.01	1.00	0.48	0.29	11	0.04	1.00	0.62	0.38	11	0.01	0.50	0.26	0.19
37	Mintom	Nkolkoumou	12	12	1.00	278212.00	49286.83	101241.92	10	0.02	1.00	0.54	0.32	9	0.04	1.00	0.51	0.35	4	0.29	0.91	0.49	0.29

Table A6. Descriptive statistics of computed indicators 6

				Number of income sources					Simpson index				Shannon-Weaver index			
	Site	Village	Sample size	N	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD
1	Ediolomo	Bakoa	33	33	2.00	8.00	3.00	1.15	0.11	0.77	0.46	0.17	0.25	1.62	0.82	0.32
2	Ediolomo	Batanga	31	31	1.00	5.00	3.00	1.01	0.00	0.69	0.34	0.19	0.00	1.27	0.58	0.31
3	Ediolomo	Bongando	31	31	1.00	6.00	3.00	1.18	0.00	0.72	0.36	0.22	0.00	1.33	0.63	0.38
4	Ediolomo	Bougnougoulouck	29	29	1.00	6.00	3.00	1.17	0.00	0.68	0.40	0.21	0.00	1.24	0.68	0.35
5	Ediolomo	Kedia	30	30	1.00	6.00	3.00	1.14	0.00	0.75	0.40	0.19	0.00	1.48	0.68	0.35
6	Ediolomo	Ossimb 1	33	33	1.00	7.00	4.00	1.30	0.00	0.75	0.42	0.19	0.00	1.38	0.76	0.32
7	Ediolomo	Tchekos	35	35	2.00	8.00	4.00	1.61	0.01	0.76	0.48	0.18	0.04	1.60	0.84	0.36
8	Ediolomo	Tobagne	30	30	1.00	7.00	4.00	1.22	0.00	0.84	0.43	0.19	0.00	1.89	0.78	0.37
9	Ediolomo	Yangben	39	39	1.00	6.00	3.00	1.12	0.00	0.69	0.32	0.22	0.00	1.27	0.54	0.38
10	Ediolomo	Yorro	33	33	2.00	7.00	3.00	1.25	0.04	0.74	0.49	0.16	0.10	1.43	0.84	0.32
11	Ayos	Abeng-nnam	29	29	5.00	8.00	5.00	0.56	0.00	1.00	0.52	0.24	0.00	1.64	0.92	0.49
12	Ayos	Bifos	24	24	5.00	6.00	5.00	0.34	0.07	0.74	0.50	0.20	0.16	1.69	0.93	0.40
13	Ayos	Mbang_2	29	29	5.00	5.00	5.00	0.00	0.00	0.73	0.44	0.22	0.00	1.39	0.79	0.41
14	Ayos	Mekouma	13	13	5.00	7.00	5.00	0.55	0.00	0.74	0.45	0.20	0.00	1.49	0.84	0.41
15	Ayos	Ndelle	34	34	5.00	6.00	5.00	0.24	0.00	0.78	0.49	0.21	0.00	1.64	0.89	0.41
16	Ayos	Ngoumesseng	33	33	5.00	6.00	5.00	0.24	0.00	0.83	0.56	0.18	0.00	1.95	1.02	0.39
17	Ayos	Niamvoudou	34	34	5.00	7.00	5.00	0.41	0.00	1.00	0.54	0.21	0.00	1.42	0.93	0.40
18	Ayos	Nkolmveng	15	15	5.00	6.00	5.00	0.26	0.00	0.76	0.46	0.19	0.00	1.50	0.80	0.37
19	Ayos	Nsan_ii	28	28	5.00	8.00	5.00	0.63	0.00	0.79	0.48	0.23	0.00	1.69	0.91	0.48
20	Ayos	Yebe	36	36	5.00	8.00	5.00	0.62	0.00	0.73	0.47	0.21	0.00	1.54	0.87	0.41
21	Lomie	Achip_2	18	18	5.00	6.00	5.00	0.24	0.00	0.79	0.46	0.21	0.00	1.73	0.85	0.42
22	Lomie	Doumzok_2	10	10	5.00	8.00	5.00	0.97	0.00	0.80	0.40	0.29	0.00	1.70	0.85	0.59
23	Lomie	Eschiambor	33	33	5.00	7.00	5.00	0.48	0.00	0.77	0.43	0.22	0.00	1.71	0.82	0.43
24	Lomie	Kongo	32	32	5.00	6.00	5.00	0.18	0.00	0.82	0.46	0.26	0.00	1.87	0.85	0.52
25	Lomie	Mayang	27	27	5.00	7.00	5.00	0.63	0.00	0.76	0.38	0.25	0.00	1.66	0.72	0.47
26	Lomie	Melene	9	9	5.00	7.00	5.00	0.73	0.22	0.67	0.49	0.16	0.38	1.40	0.87	0.36
27	Lomie	Moanguele_bosquet	30	30	5.00	6.00	5.00	0.48	0.00	0.70	0.45	0.21	0.00	1.35	0.80	0.37
28	Lomie	Nemeyong_iii	9	9	5.00	7.00	6.00	0.73	0.12	0.79	0.51	0.25	0.27	1.70	0.97	0.52
29	Lomie	Ngola	34	34	5.00	6.00	5.00	0.17	0.00	0.83	0.52	0.25	0.00	1.92	0.99	0.54
30	Mintom	Akom	30	28	1.00	4.00	2.00	0.79	0.00	1.00	0.33	0.27	0.00	1.03	0.41	0.32
31	Mintom	Assok	7	7	1.00	4.00	3.00	1.27	0.00	0.60	0.25	0.26	0.00	0.99	0.41	0.40
32	Mintom	Bite	6	6	1.00	4.00	2.00	1.26	0.00	0.51	0.22	0.24	0.00	0.85	0.36	0.41
33	Mintom	Ekombitie	20	19	1.00	4.00	2.00	1.12	0.00	1.00	0.37	0.29	0.00	1.33	0.55	0.47
34	Mintom	Lele	28	28	1.00	5.00	3.00	1.20	0.00	0.64	0.32	0.22	0.00	1.21	0.52	0.37
35	Mintom	Mboutoukong	16	16	1.00	5.00	3.00	1.41	0.00	0.65	0.38	0.27	0.00	1.23	0.64	0.47
36	Mintom	Nkolfong	15	15	1.00	7.00	3.00	1.55	0.00	0.73	0.38	0.28	0.00	1.38	0.65	0.49
37	Mintom	Nkolkoumou	12	12	1.00	4.00	3.00	0.98	0.00	0.67	0.36	0.22	0.00	1.15	0.59	0.35

Table A7. Descriptive statistics of computed indicators 7

				Wealth index				Progress out of Poverty Index (PPI)				
	Site	Village	Sample size	Min	Max	Mean	SD	N	Min	Max	Mean	SD
1	Ediolomo	Bakoa	33	-6.48	3.49	-0.08	1.59	33	12	66	35.45	11.54
2	Ediolomo	Batanga	31	-1.43	3.43	0.15	0.99	31	20	49	34.84	7.38
3	Ediolomo	Bongando	31	-2.55	1.41	-0.04	0.92	31	9	58	32.68	11.61
4	Ediolomo	Bougnougoulouck	29	-1.39	3.68	0.11	1.01	29	11	66	39.76	11.40
5	Ediolomo	Kedia	30	-2.80	2.22	-0.09	1.14	30	18	66	37.47	11.64
6	Ediolomo	Ossimb 1	33	-1.61	3.05	0.02	1.13	33	12	60	34.97	12.04
7	Ediolomo	Tchekos	35	-1.74	1.51	-0.02	0.84	35	7	57	34.94	10.97
8	Ediolomo	Tobagne	30	-2.12	2.91	-0.01	1.01	30	11	57	36.60	12.22
9	Ediolomo	Yangben	39	-1.83	1.77	-0.12	1.01	39	10	66	36.56	13.31
10	Ediolomo	Yorro	33	-2.22	1.63	-0.26	1.02	33	12	66	34.58	13.12
11	Ayos	Abeng-nnam	29	-2.25	3.12	0.10	1.12	29	11	53	28.59	9.43
12	Ayos	Bifos	24	-1.91	1.66	-0.13	1.02	24	12	46	32.75	8.61
13	Ayos	Mbang_2	29	-2.68	1.51	-0.30	1.05	29	11	60	35.62	12.49
14	Ayos	Mekouma	13	-2.06	2.35	0.24	1.32	13	25	62	41.92	12.13
15	Ayos	Ndelle	34	-2.44	5.28	0.10	1.29	34	16	54	33.91	8.51
16	Ayos	Ngoumesseng	33	-2.47	3.27	-0.05	1.32	33	5	54	28.76	11.26
17	Ayos	Niamvoudou	34	-2.62	3.82	0.07	1.31	34	16	74	36.65	13.47
18	Ayos	Nkolmveng	15	-2.78	0.69	-0.06	0.90	15	5	41	23.80	11.09
19	Ayos	Nsan_ii	28	-4.10	4.94	0.10	1.59	28	18	60	36.29	11.07
20	Ayos	Yebe	36	-1.71	1.50	0.08	0.91	36	18	59	30.50	8.77
21	Lomie	Achip_2	18	-2.33	2.03	-0.14	1.25	18	12	44	29.11	10.48
22	Lomie	Doumzok_2	10	-1.83	1.24	-0.03	0.95	10	18	53	29.60	10.83
23	Lomie	Eschiambor	33	-1.82	3.97	0.00	1.14	33	12	66	35.30	9.82
24	Lomie	Kongo	32	-4.02	1.18	-0.35	0.98	32	12	54	34.06	10.69
25	Lomie	Mayang	27	-1.90	2.28	-0.07	1.08	27	12	66	27.56	10.87
26	Lomie	Melene	9	-1.67	0.69	-0.34	0.81	9	17	56	32.89	12.46
27	Lomie	Moanguele_bosquet	30	-1.77	0.96	-0.38	0.79	30	7	48	21.53	11.31
28	Lomie	Nemeyong_iii	9	-0.77	1.37	0.58	0.81	9	19	52	35.78	10.99
29	Lomie	Ngola	34	-2.06	1.77	-0.18	0.93	34	7	54	29.18	11.08
30	Mintom	Akom	30	-1.85	2.26	0.35	1.13	30	9	48	26.90	10.14
31	Mintom	Assok	7	-1.88	1.19	-0.32	1.02	7	12	51	27.00	13.09
32	Mintom	Bite	6	-1.40	1.27	0.13	1.02	6	12	40	28.50	11.69
33	Mintom	Ekombitie	20	-1.19	5.57	0.33	1.43	20	12	48	31.25	8.72
34	Mintom	Lele	28	-3.76	1.59	0.02	1.37	28	13	47	30.39	10.11
35	Mintom	Mboutoukong	16	-2.32	4.56	0.43	1.60	16	18	75	33.38	13.34
36	Mintom	Nkolfong	15	-1.37	2.45	0.70	1.22	15	5	47	30.87	11.15
37	Mintom	Nkolkoumou	12	-0.79	2.13	0.49	0.86	12	11	40	26.83	9.81

Table A8. Descriptive statistics of computed indicators 8

				Food security score (FSS)					Food consumption score (FCS)					Household Dietary Diversity Score (HDDS)				
	Site	Village	Sample size	N	Min	Max	Mean	SD	N	Min	Max	Mean	SD	N	Min	Max	Mean	SD
1	Ediolomo	Bakoa	33	33	0.00	10.00	4.91	2.87	33	39.50	95.50	60.76	12.89	33	3.00	10.00	6.58	1.60
2	Ediolomo	Batanga	31	31	0.00	9.00	3.81	2.47	31	39.00	87.50	61.77	12.96	31	2.00	8.00	5.74	1.37
3	Ediolomo	Bongando	31	31	1.00	10.00	4.94	2.68	31	55.00	93.50	72.31	10.75	31	5.00	9.00	6.35	1.14
4	Ediolomo	Bougnougoulouck	29	29	0.00	10.00	4.34	2.42	29	34.50	89.00	60.97	12.65	29	2.00	9.00	5.69	1.51
5	Ediolomo	Kedia	30	30	0.00	10.00	5.13	2.24	30	39.00	98.00	71.57	17.35	30	2.00	10.00	5.83	1.88
6	Ediolomo	Ossimb 1	33	33	0.00	10.00	4.12	2.84	33	24.00	88.00	58.65	15.84	33	1.00	8.00	5.76	1.52
7	Ediolomo	Tchekos	35	35	0.00	10.00	5.03	2.93	35	23.50	96.50	57.74	17.58	35	4.00	9.00	6.69	1.32
8	Ediolomo	Tobagne	30	30	0.00	10.00	3.97	2.75	30	26.50	96.50	62.72	17.12	30	4.00	10.00	6.67	1.69
9	Ediolomo	Yangben	39	39	0.00	10.00	4.62	2.70	39	19.00	90.50	62.53	17.14	39	2.00	10.00	5.64	1.86
10	Ediolomo	Yorro	33	33	0.00	9.00	4.88	2.70	33	18.50	96.50	69.42	18.91	33	2.00	8.00	6.18	1.53
11	Ayos	Abeng-nnam	29	29	0.00	10.00	6.03	2.54	29	8.00	87.00	60.09	19.98	29	1.00	10.00	4.24	2.21
12	Ayos	Bifos	24	24	1.00	8.00	4.58	1.89	24	20.00	92.50	60.15	22.78	24	1.00	8.00	4.29	2.24
13	Ayos	Mbang_2	29	29	1.00	10.00	5.14	2.63	29	24.00	90.00	54.84	16.74	29	1.00	9.00	4.45	1.57
14	Ayos	Mekouma	13	13	3.00	9.00	5.38	1.56	13	29.00	86.00	60.81	16.58	13	2.00	10.00	5.00	2.45
15	Ayos	Ndelle	34	34	0.00	10.00	4.76	2.34	34	29.00	89.00	61.26	13.00	34	1.00	10.00	4.03	1.88
16	Ayos	Ngoumesseng	33	33	0.00	9.00	4.79	2.19	33	11.50	87.00	60.89	16.56	33	1.00	8.00	4.52	2.02
17	Ayos	Niamvoudou	34	34	0.00	9.00	3.65	1.82	34	34.00	89.00	66.15	12.17	34	1.00	10.00	3.88	1.75
18	Ayos	Nkolmveng	15	15	1.00	8.00	4.73	2.19	15	34.00	76.50	61.93	11.98	15	1.00	8.00	4.47	1.88
19	Ayos	Nsan_ii	28	28	2.00	9.00	5.00	1.96	28	40.50	79.00	61.25	11.31	28	2.00	10.00	4.21	1.71
20	Ayos	Yebe	36	36	0.00	10.00	5.61	2.46	36	22.50	89.00	57.81	17.02	36	1.00	9.00	4.44	1.75
21	Lomie	Achip_2	18	18	2.00	9.00	5.33	1.85	18	30.50	85.50	54.31	15.07	18	1.00	8.00	4.61	1.91
22	Lomie	Doumzok_2	10	10	1.00	10.00	4.80	3.79	10	38.50	74.50	57.70	9.57	10	2.00	6.00	4.20	1.55
23	Lomie	Eschiambor	33	33	1.00	10.00	4.70	2.54	33	29.00	79.50	56.20	13.55	33	1.00	10.00	4.33	1.85
24	Lomie	Kongo	32	32	0.00	10.00	3.97	2.81	32	28.50	93.50	58.45	16.34	32	1.00	10.00	3.88	2.37
25	Lomie	Mayang	27	27	0.00	7.00	3.93	2.04	27	21.00	90.00	56.78	19.11	27	1.00	10.00	4.89	2.29
26	Lomie	Melene	9	9	2.00	9.00	5.56	2.55	9	24.00	65.00	45.56	14.79	9	4.00	8.00	5.67	1.22
27	Lomie	Moanguele_bosquet	30	30	0.00	10.00	5.77	2.80	30	31.50	85.00	52.10	15.78	30	1.00	10.00	5.13	2.03
28	Lomie	Nemeyong_iii	9	9	0.00	5.00	2.11	1.96	9	10.50	85.00	51.00	23.59	9	1.00	6.00	3.56	1.81
29	Lomie	Ngola	34	34	0.00	8.00	4.38	2.23	34	15.00	91.00	56.19	17.39	34	1.00	10.00	4.53	1.96
30	Mintom	Akom	30	30	0.00	10.00	4.00	2.82	30	18.00	64.00	32.35	14.32	30	3.00	10.00	6.20	1.86
31	Mintom	Assok	7	7	2.00	8.00	4.14	1.95	7	33.00	59.50	46.71	9.35	7	2.00	7.00	4.57	1.62
32	Mintom	Bite	6	6	0.00	10.00	5.67	4.37	6	26.00	56.00	42.17	11.30	6	0.00	5.00	3.17	1.83
33	Mintom	Ekombitie	20	20	0.00	10.00	4.55	3.09	20	18.50	85.50	47.10	20.72	20	2.00	9.00	6.00	1.75
34	Mintom	Lele	28	28	0.00	10.00	6.25	2.52	28	18.50	86.00	45.00	17.19	28	2.00	8.00	5.04	1.82
35	Mintom	Mboutoukong	16	16	0.00	10.00	5.12	3.79	16	35.50	58.00	47.06	8.42	16	4.00	10.00	6.69	1.58
36	Mintom	Nkolfong	15	15	0.00	9.00	4.80	2.57	15	18.00	71.50	45.80	19.96	15	1.00	9.00	5.53	2.36
37	Mintom	Nkolkoumou	12	12	1.00	7.00	3.75	2.22	12	21.50	70.00	49.33	16.58	12	2.00	8.00	5.00	1.71

Annex B: Publications, projects and locations in the Cameroon SL

Table B1. List of publications, authors, projects and locations

No	Author(s)/year	Title	Location	Project
1	Eltson Eteckji Fonkeng, 2018	Nutrient dynamics in complex cocoa agroforestry systems of Bokito, Center Region of Cameroon	Bokito (Mbam and Inoubu Division) is located at 4°35’N; 11°8’E.	STRADIV
2	Emmanuel Kasereka, 2017	Caractérisation des traits fonctionnels des espèces ligneuses présentes dans les systèmes agroforestiers cocoayers en zone de transition forêt – savane: Cas de Bokito.	Bokito (Mbam and Inoubu Division) is located at 4°35’N; 11°8’E.	STRADIV
3	Annemarijn Nijmeijer, Pierre-Eric Lauri, Jean-Michel Harmand and Stephane Saj, 2018	Carbon dynamics in cocoa agroforestry systems in central Cameroon: afforestation of savanna as a sequestration opportunity	Bakoa and Guéfigué (Bokito district) latitude 4°30’N and longitude 11°10’ E	STRADIV
4	Annemarijn Nijmeijer, 2017	System legacies of past land use in complex cocoa agroforestry systems in Bokito (central Cameroon): long-term effects on ecosystem multifunctionality	Bokito district latitude 4°30’N and longitude 11°10’ E	STRADIV
5	Stephane Saj and Patrick Jagoret, 2017	Traditional cocoa agroforestry in Central Africa can provide both respectable yields and levels of ecosystem services ://www.researchgate.net/publication/320623691	Central Cameroon (Bokito 4°34’N; 11°07’E)	STRADIV
6	Eltson Eteckji Fonkeng	Carbon sequestration, nutrient dynamics and soil functioning in different trajectories of cocoa agroforestry systems in Cameroon (ongoing)	Bokito (Mbam and Inoubu Division) is located at 4°35’N; 11°8’E	SoCa
7	Gertrude Loveline Tchoudjin, 2014	Caractérisation de la communauté des arthropodes arboricoles dans les agrosystèmes à base de cacaoyers de la localité de Bokito (Région du Centre, Cameroun)	Bokito (4 parcels)	SAFSE
8	Eltson Eteckji Fonkeng, 2014	Cocoa yield evaluation and some important yield factors in smallholder Theobroma cacao agroforests in Bokito, central Cameroon	Bokito (Mbam and Inoubu Division) is located at 4°35’N; 11°8’E	SAFSE

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Table B1. *Continued*

No	Author(s)/year	Title	Location	Project
9	Marie Linda Sob Djougne, 2014	Effet de l'ombrage sur le microclimat, la pourriture brune, les mérides et la productivité dans le système agroforestier à base de cacaoyer	Bakoa (Bokito)	CIRAD/IRAD
10	Françoise Ngono, 2013	Evolution des systèmes agroforestiers cacao et stratégies des acteurs: Cas du village Talba (Mbangassina)	Talba (Mbangassina)	SAFSE
11	Patrick Kenfack Fogang, 2014	Contribution à la connaissance de la faune de la litière dans les systèmes agroforestiers à base de cacaoyers de Bokito (Région du Centre, Cameroun)	Bokito	SAFSE
12	Claire Durot, 2013	Evaluation et comparaison des stocks de carbone des systèmes agroforestiers à base de cacaoyers du Centre Cameroun : Cas de l'arrondissement de Bokito	Bakoa, Begni, Yorro and Guéfigué in Bokito	SAFSE
13	Aline Blanchet, 2014	Systèmes agroforestiers complexes à base de cacaoyers : stratégies des acteurs et types de cacaoyères en zone de front pionnier forestier au sud- est du Cameroun	Mintom II (Lélé, Ekombitié and Zoébéfam)	SAFSE
14	Louis Childéric Essola Etoa, 2014	Évaluation des rendements potentiels en cacao (theobroma cacao l) dans les systèmes agroforestiers complexes en zone forestière à pluviométrie bimodale du centre Cameroun	Cental Cameroon	SAFSE
15	Charlotte Moisy, 2013	Systèmes agroforestiers complexes à base de cacaoyers : évolutions et stratégies des acteurs, à Obala au Centre du Cameroun	Obala	SAFSE
16	Marie Armelle Bihina, 2014	Systèmes agroforestiers à base de cacaoyers: dynamiques et stratégies des acteurs dans l'arrondissement de Mintom (région sud du Cameroun)	Mintom	SAFSE
17	Kevin Yabuki Tayo Gamo, 2014	Dynamique de la biodiversite ligneuse et des stocks de carbone dans les systemes agroforestiers a base de cacaoyer au centre Cameroun: Cas de Ngomedzap	Ngomedzap	AIRD/SAFSE
18	Cyprien Alexandre, 2013	Analyse de l'usage du sol de la région de Bokito (Mbam et Inoubou, Cameroun) à partir de données de télédétection et implications sur les systèmes de culture agroforestiers.	Bokito (Mbam and Inoubu Division)	
19	André Nso Ngang, 2015	Incidence des formes de production des SAF cacao sur la sécurité alimentaire et les conditions de vie de la main d'oeuvre salariée au Cameroun	Talba	ASF4FOOD
20	Patrick Jagoret, Isabelle Michel-Dounias, Didier Snoeck, Hervé Todem Ngnogue and Eric Malézieux, 2012	Afforestation of savanna with cocoa agroforestry systems: a small-farmer innovation in central Cameroon	Bakoa, Begni, Yorro and Kedia in Bokito district	AFS4FOOD
21	Tarla Justin Ngala, 2015	Effect of shade trees on cocoa yield in smallholder cocoa (Theobroma cacao) agroforests in Talba, Central Cameroon	Talba, 4°37'47N and 11°42'25E	AFS4Food

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Table B1. *Continued*

No	Author(s)/year	Title	Location	Project
22	Sarah Langrand, 2013	Influence de l'agro-industrie sur la production de cacao au Cameroun	Cameroon	AFS4Food
23	François Essouma Manga, 2013	Systèmes agroforestiers à base de cacaoyers: Dynamiques et stratégies des acteurs à Akongo (région du Centre)	Akongo (Mengueme, Agonfeme, Ekoud-Bessanda, Abang-Akongo and Akongo I, II, III)	AFS4FOOD/ SAFSE
24	Madeleine Bakemhe, 2014	Evaluation des rendements des cultures Vivrieres et leur contribution dans le revenu Agricole des menages a Talba dans le centre Cameroun	Talba	AFS4FOOD
25	Amougou Joseph Armathe. Tchindjang Mesmin, Haman Unusa, Batha Romain Armand Soleil, 2013	A comparative study of the influence of climatic elements on cocoa production in two agrosystems of bimodal rainfall: Case of Ngomedzap forest zone and the contact area of forest savanna of Bokito	Bokito	-
26	Anne-Laure Boulaud, 2014	Agriculture familiale au Cameroun: analyse comparée entre forêt et savane	Mindourou and Guéfigué	CoForTips
27	Micresse Gaingne Kamto, 2016	Dynamique d'évolution du socio-écosystème forestier de l'arrondissement du Dja à l'Est Cameroun : acteurs, interactions et perspectives d'évolution	Mindourou	CoForTips
28	TN Madountsap et al., 2018	Biodiversity and carbon stock in the SODECAO agroforestry system of Center Region of Cameroon: Case of Talba locality.	Talba (Mbangassina)	CoForTips
29	Charlotte Lehnebach	Caracterisation du socio-ecosysteme "Mindourou" (Cameroun) et identification des strategies d'acteurs.	Mindourou	CoForTips
30	J Oszwald, V Gond, B Tchiengué, NB Farrel, D Dallery, C Garcia, 2015	Description des éléments paysagers des classifications d'occupation des sols	Mindourou and Gueboba	CoForTips
31	Kevin Yabuki Tayo Gamo, 2014	Evaluation et comparaison des stocks de carbone des systèmes agroforestiers à base de cacaoyers du Centre Cameroun: Cas de l'arrondissement de Bokito.	Bokito	CoForTips
32	Giles Christian Somgwag Kamsu, 2014	Modélisation participative de la paysannerie agricole sur le territoire de Guéfigué et Guéboba	Guéboba:	CoForTips
33	Elisabet Codina Llavina, 2014	Caractérisation du socio-écosystème formé par Guéboba et Guéfigué, région de Bokito (Cameroun)	Bokito	CoForTips
34	LA Duguma, PA Minang, D. Foundjem-Tita, P. Makui and S. Mandiefe Piabuo, 2018	Prioritizing enablers for effective community forestry in Cameroon	Cameroon	DRYAD
35	S Mandiefe Piabuo, D Foundjem-Tita and PA Minang, 2018	Community forest governance in Cameroon: a review	Cameroon	DRYAD

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Table B1. *Continued*

No	Author(s)/year	Title	Location	Project
36	PA Minang, LA Duguma, S Mandiefe Piabuo, D Foundjem-Tita, and Z Tchoundjeu, 2018	Community forestry as a green economy pathway: two decades of learning in Cameroon	Cameroon	DRYAD
37	PA Minang, LA Duguma, S Mandiefe Piabuo, D Foundjem-Tita, and Z Tchoundjeu, 2018	La foresterie communautaire comme voie de l'économie verte: deux décennies d'apprentissage au Cameroun	Cameroon	DRYAD
38	H Cosyns, P Van Damme, R De Wulf and A Degrande, 2013	Can rural development projects generate social capital? A case study of *Ricinodendron heudelotii* kernel marketing in Cameroon	Cameroon	Agroforestry Tree Products for Africa
39	H Cosyns, A Degrande, R De Wulf, P Van Damme and Z Tchoundjeu, 2011	Can commercialization of NTFPs alleviate poverty? A case study of *Ricinodendron heudelotii* kernel marketing in Cameroon	Cameroon	Agroforestry Tree Products for Africa
	A Degrande, S Franzel, Y Siohdjie Yeptiep, E Asaah, A Tsobeng and Z Tchoundjeu, 2012	Effectiveness of grassroots organisations in the dissemination of agroforestry innovations	Cameroon	Agroforestry Tree Products for Africa
40	A Degrande, P Tadjo, B Takoutsing, E Asaah, A Tsobeng and Z Tchoundjeu, 2012	Getting trees into farmers' fields: Success of rural nurseries in distributing high-quality planting material in Cameroon	Cameroon	Agroforestry Tree Products for Africa
41	C Facheux, A Gyau, D Foundjem-Tita, D Russell, C Mbosso, S Franzel and Z Tchoundjeu, 2012	Comparison of three modes of improving benefits to farmers within agroforestry product market chains in Cameroon	Cameroon	Agroforestry Tree Products for Africa
42	D Foundjem-Tita, M D'Haese, A Degrande, Z Tchoundjeu and P Van Damme, 2011	Farmers' satisfaction with group market arrangements as a measure of group market performance: A transaction cost analysis of non-timber forest products' producer groups in Cameroon	Cameroon	Agroforestry Tree Products for Africa
43	D Foundjem-Tita, A Degrande, M D'Haese, P Van Damme, Z Tchoundjeu, A Gyau, C Facheux and C Mbosso, 2012	Building long-term relationships between producers and trader groups in the non-timber forest product sector in Cameroon	Cameroon	Agroforestry Tree Products for Africa
44	D Foundjem-Tita, Z Tchoundjeu, S Speelman, M D'Haese, A Degrande, E Asaah, G Van Huylenbroeck, P Van Damme and O Ndoye, 2012	Policy and legal frameworks governing trees: Incentives or disincentives for smallholder tree-planting decisions in Cameroon?	Cameroon	Agroforestry Tree Products for Africa
45	D Foundjem-Tita, S Speelman, JC Tieguhong, M D'Haese, A Degrande, Z Tchoundjeu, O Ndoye, G Van Huylenbroeck and P Van Damme, 2013	A choice experiment approach for assessing preferences to forest law configuration and compliance: The case of NTFP traders in Cameroon	Cameroon	Agroforestry Tree Products for Africa
46	A Gyau, C Mbosso, Z Tchoundjeu, D Foundjem-Tita, E Asaah and S Franzel, 2011	Antecedents and effects of group sales on supply chain performance: The case of kola production and marketing in Cameroon	Cameroon	Agroforestry Tree Products for Africa

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Table B1. *Continued*

No	Author(s)/year	Title	Location	Project
47	A Gyau, B Takoutsing and S Franzel, 2012	Farmers' perception of collective action in kola supply chain: Cluster analysis results	Cameroon	Agroforestry Tree Products for Africa
48	A Gyau, B Takoutsing, A Degrande and S Franzel, 2012	Producers' motivation for collective action for kola production and marketing in Cameroon	Cameroon	Agroforestry Tree Products for Africa
49	A Gyau, M Chiatoh, S Franzel, A Asaah and J Donovan, 2012	Determinants of farmers' tree planting behavior in the North West region of Cameroon: the case of *Prunus africana*	Cameroon	Agroforestry Tree Products for Africa
50	B Takoutsing, A Degrande, Z Tchoundjeu, E Asaah and A Tsobeng, 2012	Enhancing farmers access to quality planting materials through community-based seed and seedling systems: Experiences from the Western Highlands of Cameroon	Cameroon	Agroforestry Tree Products for Africa
51	Z Tchoundjeu, A Degrande, R Leakey, G Nimino, E Kemajou, E Asaah, C Facheux, P Mbile, C Mbosso, T Sado and A Tsobeng, 2010	Impact of participatory tree domestication on farmers livelihoods in West and Central Africa	Cameroon	Agroforestry Tree Products for Africa
52	Z Tchoundjeu, E Asaah, J Bayala, A Kalinganire and S Mng'omba, 2012	Vegetative propagation techniques		Agroforestry Tree Products for Africa
53	Z Tchoundjeu, E Asaah, I Dawson and R Leakey, 2012	The participatory tree domestication approach	Cameroon	Agroforestry Tree Products for Africa
54	G Van Huylenbroeck, M D'Haese, D Foundjem-Tita and J Viaene, 2010	Understanding institutional arrangements for improved market access in Africa: How to explain seemingly irrational causes of success and failure	Africa	Agroforestry Tree Products for Africa
55	A Degrande, M Bwama Meyi, R Caspa, D Dibwe, E Asaah, A Biloso, C Okwu and Z Tchoundjeu, 2011	Rural resource centers transform lives and landscapes through participatory tree domestication in West and Central Africa	West and Central Africa	Agroforestry Tree Products for Africa
56	A Degrande, Y Yeptiep Siohdjie, S Franzel, E Asaah, B Takoutsing, A Tsobeng and Z Tchoundjeu, 2011	Disseminating agroforestry innovations in Cameroon: Are relay organizations effective?	Cameroon	Agroforestry Tree Products for Africa
57	D Foundjem-Tita, P Van Damme, A Degrande, Z Tchoundjeu and M D'Haese, 2010	Institutional arrangements are a driving force for NTFPs as a livelihoods option: Case study of ADEAC, Cameroon	Cameroon	Agroforestry Tree Products for Africa
58	C Mbosso, D Foundjem-Tita and C Facheux, 2009	Why is marketing of agroforestry tree products a social and gender-blind technology? The case of Cameroon	Cameroon	Agroforestry Tree Products for Africa

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Table B1. *Continued*

No	Author(s)/year	Title	Location	Project
59	B Takoutsing, A Degrande, E Asaah, A Tsobeng, Z Tchoundjeu and T Sado, 2011	Enhancing farmers' access to quality planting material: Community-based seed and seedling systems in the Western Highlands of Cameroon	Cameroon	Agroforestry Tree Products for Africa
60	World Agroforestry Centre-WCA/HT, 2012	Book of abstracts. International Symposium on Tree Product Value Chains in Africa: Sharing Innovations That Work for Smallholders. Yaounde, 26–28 November 2012	Cameroon	Agroforestry Tree Products for Africa
61	D Foundjem-Tita, 2013	A new institutional economic analysis of policies governing non-timber forest products and agroforestry development in Cameroon	Cameroon	Agroforestry Tree Products for Africa
62	H Cosyns, 2013	*Ricinodendron heudelotii* kernel group commercialization and its impact on farmers' livelihoods in Cameroon	Cameroon	Agroforestry Tree Products for Africa

WORKING PAPER

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This publication is part of the Sentinel Landscape network initiative established in eight sites around the world representative of widely different biophysical and socioeconomic contexts. Here we present and summarize the results of the research and baseline studies carried out in the Central Africa Humid Tropics Transect sentinel landscape, four sites in Cameroon indicative of the African humid forest ecological zone.

The CGIAR Research Program on Forests, Trees and Agroforestry (FTA) is the world's largest research for development program to enhance the role of forests, trees and agroforestry in sustainable development and food security and to address climate change. CIFOR leads FTA in partnership with ICRAF, the Alliance of Bioversity International and CIAT, CATIE, CIRAD, INBAR and TBI.

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