Forest Management plan

Asubima and Afrensu Brohuma Forest Reserves
Ashanti Region, Ghana

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Contents

Letter of the Director

Management is not a rigid concept but rather a flexible process, adapted to changes in the field. To keep track of these changes, Form Ghana developed a monitoring system for systematic collection of data. These data are analysed, results are evaluated and used to improve the management plan.

Management protocols complement the management plan, providing detailed guidelines for standard operations.

Form Ghana ltd.

Willem Fourie
Managing Director
November 2021

1 INTRODUCTION

This document is the Management Plan of Form Ghana. It describes the policy and long-term planning for the management of the company, and indicates what has been achieved so far. This chapter starts with a brief introduction of the context of Ghana's forest and timber industry. Then, the company Form Ghana Ltd. is presented and the structure of the management. This chapter ends with an overview of the report structure.

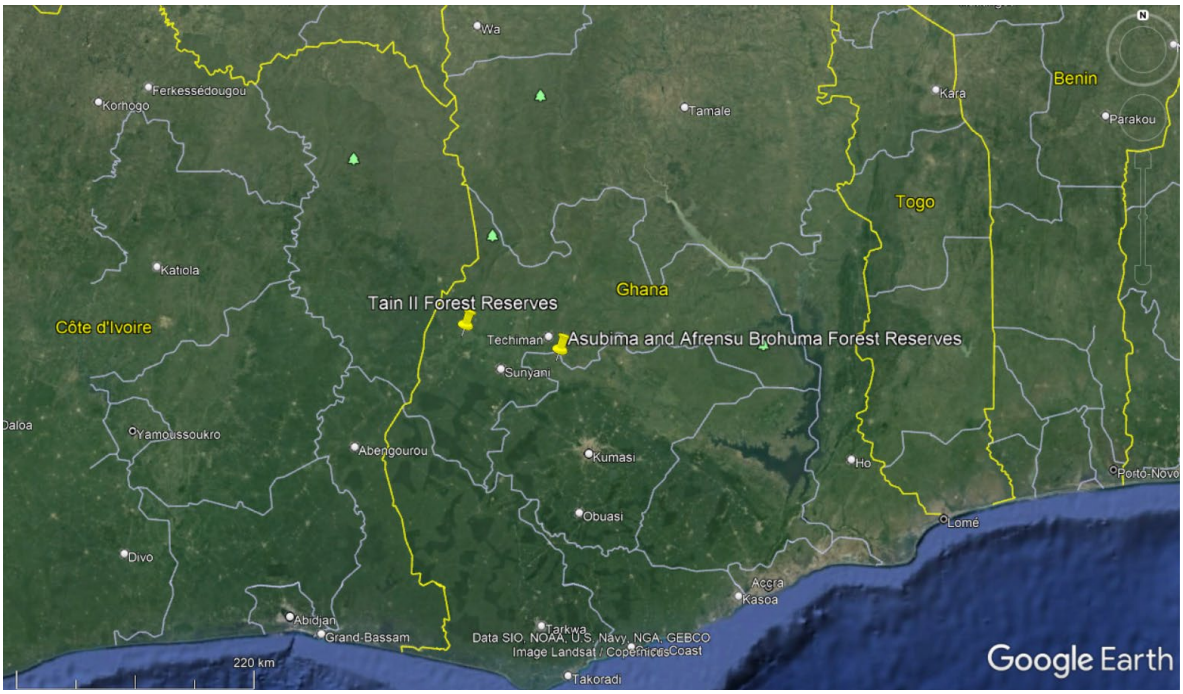
1.1. Ghana's forest and timber industry

Ghana's forest area has been reduced over the last decade, due to over-exploitation and encroachment of its forest reserves. Ghana's present forest resources sustain a maximum annual allowable cut of about 1 million m³ of timber, while the export-oriented wood industry has an installed capacity of around 3.7 million m³ and local demand for firewood will reach about 3 million m³ by 2020.

Forest Reserves are managed by the Forestry Services Division of the Forestry Commission. Harvesting is carried out under logging concessions by private companies. The forestry sector is reported to contribute to 2.8% of the Gross Domestic Product (2011) and is characterised by excess capacity relative to the availability of raw material. Ghana has made considerable efforts towards bringing her natural forests under sustainable management. The National Forest Plantation Development Programme (NFPDP) aims at reforestation of degraded Forest Reserves and private lands via multiple strategies, among others through land leases and benefit sharing agreements with private investors.

1.2. Reforestation by Form Ghana

Form Ghana Ltd. is owned by Sustainable Forestry Investments the Netherlands (SFI NL) and based in central Ghana. The company was established in 2007 and has since then been active in the north of the Ashanti Region, near Akumadan, where the company has reforested the highly degraded Asubima and Afrensu Brohuma Forest Reserves in 2008 and 2011 respectively. Further to this it is current restoring areas in Tain II Forest Reserve, near Berekum in the Bono Region. (See Map 1 below).



Map 1: Location of Form Ghana plantations in Ghana

1.3. Management of Akumadan Forest Reserves

Management plan

Form Ghana Ltd. (Form Ghana) has elaborated a reforestation plan for the establishment of a commercial timber plantation in the Asubima and Afrensu Brohuma Forest Reserves, which after submission was approved by the Forestry Commission of Ghana. However, since the reforestation plan was too general to work with in the field, Form Ghana elaborated a management plan for the company's reforestation activities in these Forest Reserves. This management plan is part of ongoing revisions to this initial management plan.

The Management Plan describes the management system of Form Ghana Ltd., based on the FSC™ (FSC-C044035) Principles and Criteria, includes the following topics:

- An overview of the physical environment (climate, water and soil condition, biodiversity, etc.) and social-economic environment (village facilities, occupation, level of education, housing and transportation etc.) of Asubima and Afrensu Brohuma FR.
- The forest management objectives, elaborating on each of the three sustainability pillars (ecological, economic and social) and it describes the way land-use is impacted on the long-term
- The organization of the managed areas including the plantation infrastructure and field planting program
- The tree species selection and forest type allocation
- Tree nursery practices
- The various silvicultural practices that will be carried out during the entire plantation rotation cycle
- Risk management, including prevention of illegal activities, fire management and control of pests
- A social plan that covers the involvement of stake-holders, benefit sharing, employment and intercropping by local farmers
- Environmental management, concentrating on soil and water, biodiversity and High Conservation Value Forests
- The various monitoring activities

A number of studies and reports was used as input for this Management Plan, each based on relevant preliminary studies of the area:

- previous Forest Management Plans of Asubima and Afrensu Brohuma Forest Reserves
- The Social and Environmental Impact Assessments (SEIA) report for Asubima and Afrensu Brohuma FR
- Biodiversity Studies commissioned by Form Ghana of the relevant areas under their management control
- The High Conservation Value Forest analyses of Asubima and Afrensu Brohuma Forest Reserves

Management procedures, Policies and stand sheets

Complementary to the Management Plan, Form Ghana uses a system of separate protocols and policies that describe the processes of environmental and social management. A list of the protocols and policies is included in Annex A of this Management Plan. Throughout the management plan, reference will be made to these.

Also, there are stand sheets which are filled in or updated every planting year. These stand sheets form the basis of the operational management plan (see chapter 13). They describe the area planted per year and the way in which that area will be managed specifically. They are important to keep track of the stands and to conserve information through time. For an example see Annex B.

Monitoring

Management is a continuous process. This means that it will be adapted over time because of changes in the field or new insights. To keep track of these management changes, Form Ghana applies a monitoring system which involves annual information gathering on plantation growth and condition, social impact, soil and water protection and biodiversity (see chapter 12).

The effectiveness of management is checked annually through monitoring activities. The Management Plan, Policies and Protocols serve as input for the monitoring system. Findings from monitoring activities are fed back into the management system through the adaptation of protocols, policies or management plans. The process of evaluation and adaptation will lead to further fine-tuning of the management plan. The relations between the various documents are described in the schedule below (figure 1.2).

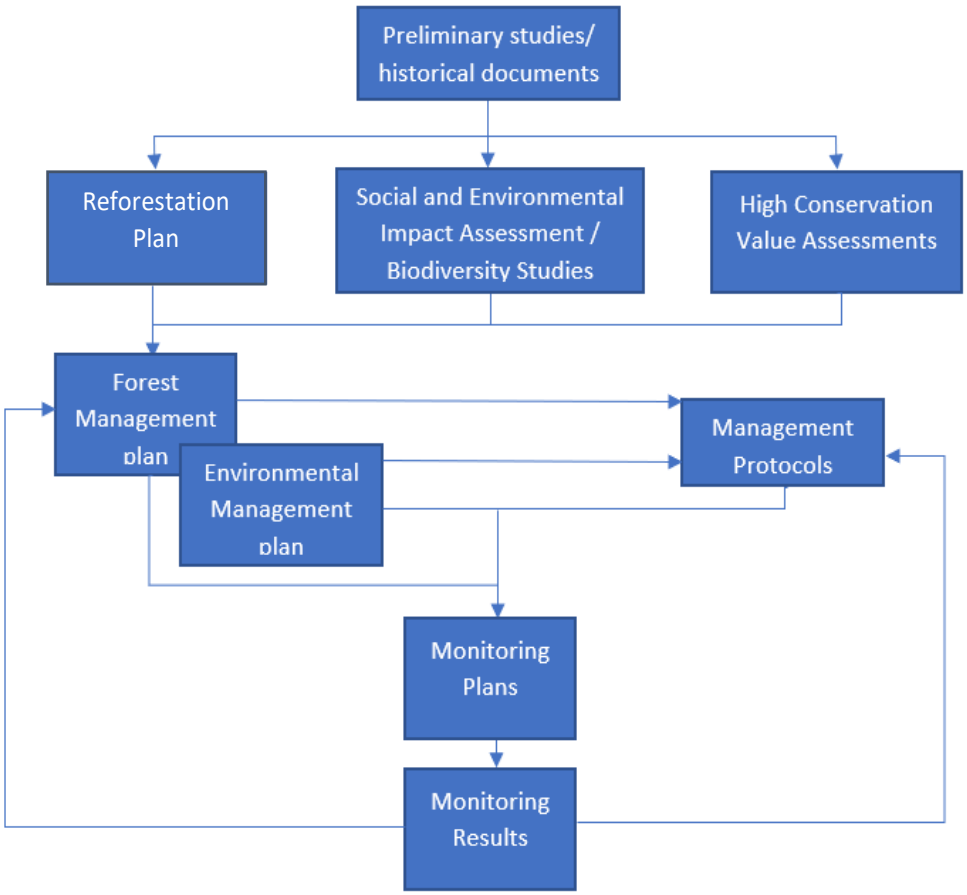


Figure 1. Links between various documents

Validity of management plan

As is mentioned in the section above, the management plan is reviewed annually and updated every 5 years to incorporate new information from the field. Every year during the dry season, the plan is closely compared with the current situation in the Forest Reserve areas. If the field situation has changed, the management plan is adapted accordingly. Likewise, information from monitoring is used to update the management plan (if the nature of the information dictates so).

1.4. Report structure

This management plan first introduces the company Form Ghana Ltd and the sustainability approach taken (Ch. 2). Then, in chapter 3 an overview is presented of the physical environment (climate, water and soil condition, biodiversity, etc.) and social-economic

environment (village facilities, occupation, level of education, housing and transportation etc.) of the Forest Reserve areas.

Chapter 4 states the forest management objectives elaborating on each of the three sustainability pillars (ecological, economic and social) and it describes the way land-use is impacted on the long-term. The organisation of the managed areas is presented in chapter 5 including the plantation infrastructure and field planting program. The tree species selection and forest type allocation are described in chapter 6, followed by the tree nursery practices in chapter 7. Chapter 8 gives a full description of the various silvicultural practices that will be carried out during the entire plantation rotation cycle.

Chapter 9 is devoted to risk management including prevention of illegal activities, fire management and control of pests. The social plan (chapter 10) covers the involvement of stakeholders, benefit sharing, employment and intercropping by local farmers. Environmental management, concentrating on soil and water, biodiversity and High Conservation Value Forests, is covered in chapter 11. The various monitoring activities are described in chapter 12. Finally, the set up and maintenance of the operational management plan are discussed in chapter 13.

1.5. The Company

1.5.1. Company information

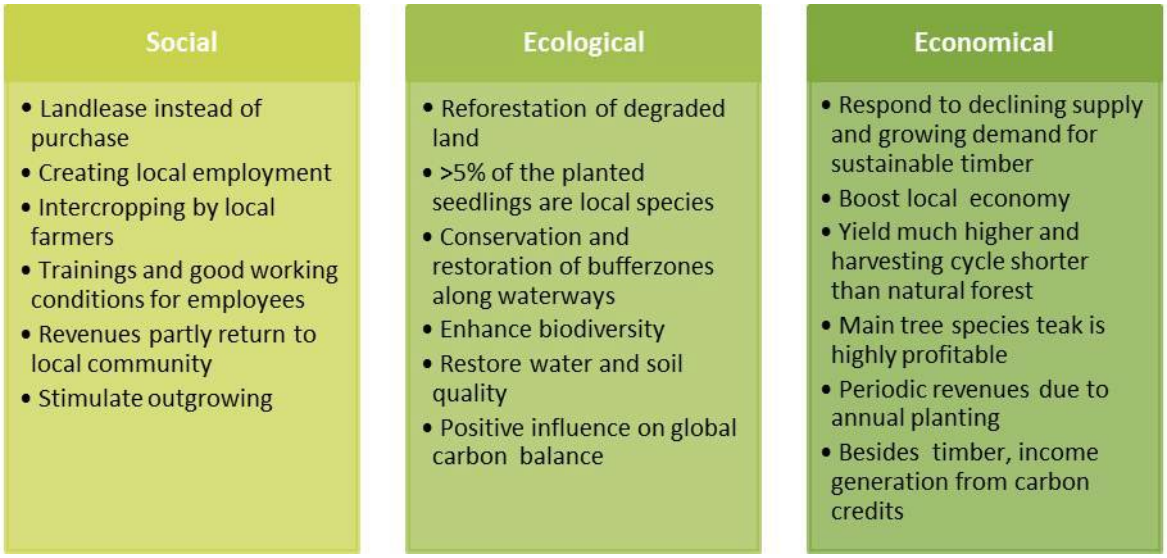
Form Ghana Ltd. is a forest plantation management company, based in central and Western Ghana (Figure 1). The company was established in 2007. The core business of Form Ghana is the restoration of some of Ghana's Forest Reserves as part of the Ghana government's strategic plans for these Forest Reserve areas. This will be achieved through the establishment and management of sustainable forest plantations to restore land, carbon sinks and strategic timber resources and the restoration and protection of indigenous forest areas, in degraded forest reserves. These areas used to be productive semi-deciduous forest ecosystems until overexploitation, bush fires and illegal conversion to agricultural land caused severe degradation of the land and natural resources prior to Form Ghana acquiring management control of the areas.

This chapter first elaborates on the core value of Form Ghana: sustainability. Directly linked to that, paragraph 2.2 is about the corporate social responsibility of Form Ghana. Then, in paragraph 2.3 details are given of the legal compliance of Form Ghana, the organisational structure is presented in 2.4 and the infrastructure is briefly described in paragraph 2.5.

1.5.2. Sustainability

Form Ghana envisions carrying out its activities in a social, ecological and economical responsible way. The figure below gives an overview of Form Ghana's unique sustainability concept that is applied in all the plantation units managed by Form Ghana.

The unique sustainability concept of Form Ghana



High quality on a technical as well as on a social and environmental level is the key to success for Form Ghana. This has resulted in FSC™ (https://ic.fsc.org)certification for responsible forest management in 2010. and validation of a reforestation carbon project under the Verified Carbon Standard (VCS) since 2013. 'Under VCS, projects are issued unique carbon credits known as Verified Carbon Units or VCUs. Each VCU represents a reduction or removal of one ton of carbon dioxide equivalent (CO_2e), which can be generated by reducing or removing greenhouse gases.' (www.v-c-s.org)

The sustainability policy of Form Ghana is presented below. In the following chapters these aspects will be elaborated in detail for the Akumadan forest reserves.

Sustainability Policy of Form Ghana Ltd.

Form Ghana commits itself to manage its plantations in a responsible and socially, environmentally and economically sustainable way. To this end, it strives to operate in compliance with the Principles and Criteria of the Forest Stewardship Council (FSC™).

In this way, the company will contribute significantly to the environment, the Ghanaian economy and to the quality of life of people related to and in the direct vicinity of the company. High quality on a technical as well as on a social and environmental level is the key to success for Form Ghana.

Form Ghana offers its employees a safe and healthy working environment, with good employment terms, favourable insurance policy conditions and pension build-up. Besides employment, local people can benefit indirectly from the activities of Form Ghana, through revenue sharing.

Form Ghana aspires to conserve and restore biological diversity, water sources, and fragile ecosystems found in or near its plantations. Plantations will be managed in such a way that they will contribute to climate change mitigation by having a positive influence on the global carbon balance.

The production from forest plantations certified for sustainable management will ensure the enhancement of the local economy and a guaranteed timber supply for the forest industry.

Form Ghana will operate with respect to Ghanaian laws as well as the international conventions valid in Ghana.

1.5.3 **Corporate Social Responsibility**

Form Ghana aspires to continue meeting the standards of the Forest Stewardship Council (FSC™). Besides technical performance, Form Ghana has a policy for the corporate social responsibility.

Corporate Social Responsibility Policy of Form Ghana Ltd.

Code of conduct
Form Ghana will uphold and / or develop cultural values by respecting local customs and maintaining good relations with the local chiefdoms.

Form Ghana will not allow any form of discrimination to take place on the premises. Discrimination based on race, sex, sexual preference, age or religion is explicitly prohibited at Form Ghana.

Employment
At Form Ghana all labour is voluntary and regulated by contracts that were negotiated in freedom. No forced labour shall take place on Form Ghana premises.

At Form Ghana there shall be no child labour. No people are employed that are less than 18 years of age.

There is a preference to employ people from the neighbouring towns and villages to stimulate the local economy. If specific expertise/ background is not available locally, Form Ghana will employ people from elsewhere. Employees are preferably housed in their own houses. The company organises the transport from a central collecting point to the nursery and the plantation. For staff living outside the area the company will provide appropriate lodging facilities.

Workers receive the training necessary to adequately perform their jobs. Most of this training is on the job and repeated annually. In some cases, special schooling may be awarded when deemed necessary by the management.

Payment
Workers will receive at least the nationally agreed minimum wage. For the permanent staff this salary can be transferred to the respective bank accounts of the employees or be paid cash. For temporary workers payment will be in cash.

Form Ghana pays the SNITT for the permanent workers as is due.

Form Ghana offers a possibility for a loan to permanent workers.

Worker's unions
At Form Ghana the employees have all rights for organisation and collective negotiations.

A Consultative structure exists consisting of worker representatives who meet with management on a monthly basis.

Safety
Form Ghana has performed a health and safety analysis in the workplace. Based on this analysis a schedule of safety equipment has been drawn up. This equipment is provided to the relevant workers.

Form Ghana provides water from a tested source for its employees.

Form Ghana has a first aid centre with a trained nurse. Employees are trained in providing first aid annually. Also, there is an agreement with the Holy Family hospital in Techiman and the Holy Family Hospital in Berekum, so that injured workers of Form Ghana will be admitted immediately and paperwork is arranged later. Workers who have fallen ill can have their medical expenses refunded against presentation of the bills of medicines and a doctor's order for these same medicines.

Form Ghana insures the permanent workers through the national health insurance programme. This insurance covers the medical costs of workers and their families.

Local farmers
Form Ghana collaborates with farmers through, among others, the following arrangements:

- Providing farmers with temporary access to farm land within the plantation according to specified criteria and options set by Form on a sustainable basis (this concerns intercropping).
- Allowing farmers to grow certain crops on the fire belt.
- Provide training in bush fire prevention and fighting for the fringe communities.
- Ensure high safety standards in the entire operation and access to better health care facility to the fringing communities.
- Transparent benefit sharing with relevant stakeholders.

1.5.4 **Legal compliances**

Form Ghana Ltd. is officially established in Ghana through documents CA-387,338/2421 (registration certificate), CA-37,338 (certificate of incorporation) and CA-37,338 TIN 824VO25997 (certificate to commence business).

The Akumadan leases and Benefits Sharing Agreements were signed in March 2009 for Asubima Forest Reserve and September 2012 for Afrenso-Brohuma Forest Reserve. The leases on the two Reserves cover a total land area of 3,447 hectares.

Form Ghana implements its activities according to the applicable national legislation and international conventions. Protocol P01 describes in detail how this is realised by the company.

1.5.5. Infrastructure

Offices

Form Ghana has offices in three locations. One office is built in Akumadan near the plantations established in Asubima FR and Afrensu Brohuma FR. Another office is located in Kotaa near the Tain II FR. Finally, there is an office located in Sunyani.

Workshops and Stores

Workshops and stores have been established near the plantations at the Akumadan and Kotaa Office sites

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2 SITE DESCRIPTION

In this chapter some background information is given on the project area. First, the physical environment is described (climate, soils, topography, hydrography, vegetation and fauna) followed by the social characteristics (household size, age & occupation, housing & transportation, ethnicity & religion, village facilities, level of education, health and farming practices). In-formation included in this chapter is obtained from the initial Social and Environmental Impact Assessment.

Form Ghana operates in three degraded forest reserves in Ghana, two are in the Ashanti Region and covered by this plan: Asubima and Afrensu Brohuma (Figure 2). Both are situated in the dry semi-deciduous forest zone. Both Forest reserves fall under the authority of the Forestry Commission in Offinso District. Asubima FR and Afrensu Brohuma FR share a common boundary over 4,800m of which 1,600m is part of the Form Ghana concessions.

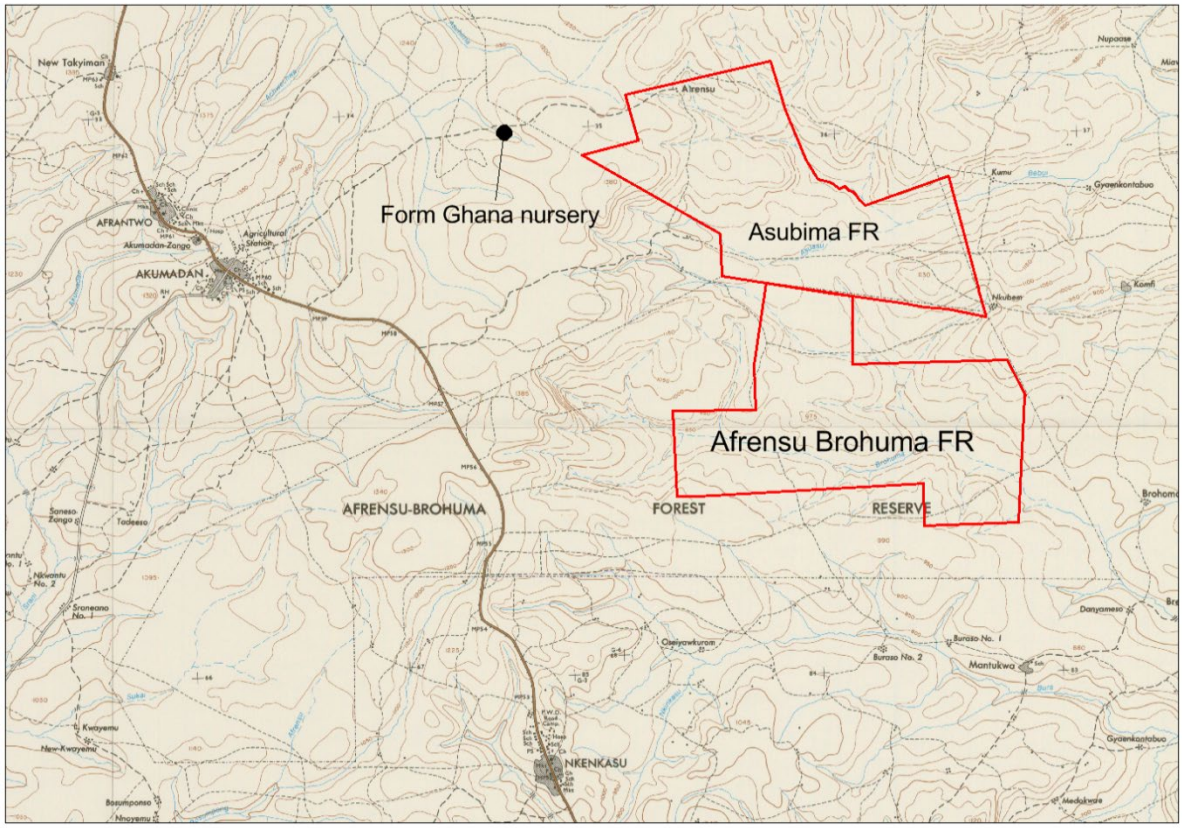

Figure 1. *Outlines of the plantation and the position of the nursery*

2.1 Climate

Asubima and Afrensu Brohuma Forest Reserves lie at the northern fringes of the semi-deciduous forest zone of Ghana. The zone has a tropical monsoon climate with alternating wet and dry seasons (Figure 3). The long rainy season (March to July) is followed by a short dry period (July/August) and a short rainy period (September/October) before the long dry season starts (November to March).

Temperatures are generally high and uniform throughout the year (Figure 3). Mean annual temperature is 26°C. February and March are the warmest months. The total average annual rainfall is 1227 mm. More detailed climatic data can be found in the report “Detailed soil survey and suitability assessment of a pilot site for teak development in the Asubima Forest Reserve”.

For teak, a mean annual temperature of 22-27°C and an annual precipitation of 1200-2000 mm/y are optimal (Keogh and Pentsil, 2001). Both temperatures (24-27°C) and rainfall (1227mm) in Asubima and Afrensu Brohuma FR fall well within this range.

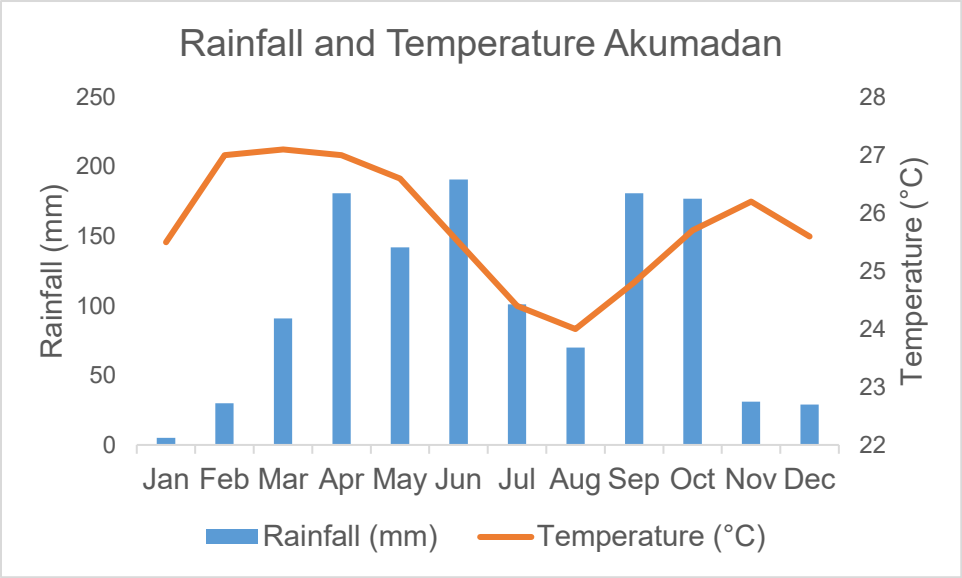

Figure 2. *Monthly rainfall and temperature in Akumadan. Source: [www.worldclimate.org.](http://www.worldclimate.org)*

2.2 Abiotic environment

The geology of the area is important for the growth of the planted forest. Form Ghana takes into account the nature of the terrain as much as possible both in plantation establishment and maintenance.

The terrain is undulating with a large ridge running from the east to the west, topped with a nearly horizontal layer of sandstone. Slopes are moderate, between 5-10% in steepness, and the hills have flat tops. Rock outcrops occur in several places in the survey area, but generally cover only small areas.

Both forest reserves have a small network of streams, some of which originate in the reserves. The severe forest degradation affected the existing water bodies. Analyses of samples of the water bodies in both forest reserves show severe deterioration of quality parameters such as pH, turbidity, dissolved oxygen (DO), conductivity and nitrate content. Water volume/level was reduced due to siltation and evaporation. More information on water quality measurements can be found in the hydrological report for Asubima Forest Reserve, Social and Environmental Impact Assessments and High Conservation Value studies for Asubima and Afrensu Brohuma Forest Reserves.

The soils in the area have developed in weathered sandstone and generally have a sandy loam to sandy clay loam texture. Deeper horizons have a clay loam to clay texture due to illuviation of clay particles. The detailed inventories of the soils in Asubima and Afrensu Brohuma Forest Reserves are presented in the reconnaissance soil survey reports by H. Scholten.

2.3 Flora & Fauna

Valuable timber trees such as Wawa, Odum, Sapele and Kokrodua are characteristic for the area (Amponsa-Kwatiah, 1993). Inventories prior to Form Ghana leasing the land demonstrated that there is virtually no stretch of land within the project area covered with natural forest due to intensive farming and reported annual fires (Abeney et al., 2008). Weeds and grasses (e.g. *Chromolaena odorata* (Akyeampong) and *Pennisetum purpureum* (Elephant grass)) and *Broussonetia papyrifera* (York), introduced for fibre production, have replaced the original high forest, hampering native forest restoration. A single Kokrodua tree (*Pericopsis elata*) was observed in the field by Form Ghana staff members in 2009. Kokrodua is a species listed as endangered on the IUCN Red List and also listed on Appendix II of CITES (IUCN,

2011). Seeds from this tree were collected and cultivated in the nursery for reforestation purposes.

As part of the initial Social and Environmental Impact Assessment (SEIA), a flora and fauna inventory showed a vegetation cover typical for highly degraded areas, while most species of birds and small mammals were common in the area and typical for savannah vegetation. The detailed inventories can be found in the SEIA reports.

In the first quarter of 2021 Form Ghana commissioned a biodiversity study to be conducted by KNUST with the key findings being an increase fauna species observed in the two Forest Reserve areas under Form Ghana's control. This study also revealed increases in both the number of indigenous trees species and trees per hectare in both forest Reserves, with substantial increases in tree basal area in the indigenous areas. Detailed inventories can be found in the Biodiversity Report of 2021. See Table 1 below for key species identification during the study.

IUCN Status	**Flora**	**Mammals**	**Birds**	**Reptiles**	**Total**
Critically Endangered (CR)	-	-	-	-	-
Endangered (EN)	-	Tree Pangolin; *Phataginus tricuspis*	-	-	1
Vulnerable (VU)	*Pseudospondias microcarpa; Cedrela odorata; Khaya anthotheca; K. ivorensis; K. senegalensis; Entandrophragma cylindricum*	Lowe's Mona Monkey; *Cercopithercus lowei*	-	Dwarf Crocodile; *Osteolaemus tetraspis*	8
Near Threatened (NT)	*Hallea ledermannii Milicia excelsa*	-	-	-	2
Least Concern (LC)	44	15	60	-	118
Data Deficient (DD)	-	-	-	-	-
Not Evaluated (NE)	12	-	-	-	12
Total Species	**63**	**17**	**60**	**1**	**141**

Table 1: 2021 Biodiversity assessment results for species of conservation significance.

Form Ghana re-established a number of tree species, including Ghana scarlet star-rated species, in both Forest Reserves as part of their forest restoration programme in identified indigenous forest areas. (see table 5.1 in chapter 5.3 of this document).

2.4 Socio-economic environment

Extensive initial social assessments have been done in Asubima and Afrensu Brohuma Forest Reserves, in 2008 and 2012 respectively. The main conclusions of the last SEIA are included below. More detailed information can be found in the SEIA reports for both forest reserves. An annual social survey is undertaken by Form Ghana to maintain consultations with surrounding communities and individual farmers. These results are included in the annual monitoring reports.

SEIA Afrensu Brohuma FR:

No major negative impacts of the proposed project were identified in Afrensu Brohuma FR. The moderate impacts are related to the loss of farmland and reduced productivity of farmers

now farming within the reserve. However, this impact should be considered in the light of their illegal status now, farming within reserve boundaries. The people from Libya (village located within the forest reserve, red.) expressed that they preferred the restrictions posed by the proposed project to the uncertainty of their illegal situation, in which they constantly fear eviction by the Forestry Commission. However, many of the surrounding farmers complained about the land-use restrictions posed by the FSC™ regulations and some expressed their concerns about the quantity of their yield and whether it would be sufficient for their families to live from. Also, the farmers within the reserve wondered where they could go after canopy closure would make farming impossible.

SEIA Asubima FR:
The project will largely bring positive impacts to both the environment and the society. Since Asubima Forest Reserve is severely degraded it is rather a matter of urgency that the place should be given forest cove and the appropriate incentive to do this is the economic benefit that Form is pursuing through planting teak. Teak has a respectable and readily profitable market worldwide and this should provide sustainable basis for the operations of this company to continue to provide good forest cover for Asubima forest reserve. The consultants are confident that the benefits far outweigh the negative effects which are minimal.

3 PRACTICAL INFORMATION

3.1 Plantation infrastructure

One feeder road connects Form Ghana's plantations in Asubima and Afrensu Brohuma FR with the national road network. It diverts from the highway 3km south from the town of Akumadan and stretches for 7km to the boundary of the forest reserves. Construction and maintenance is done by the Ghana Irrigation Development Authority (GIDA).

Form Ghana constructed a road network within and along the plantations, some following quadrant lines, some following old logging roads and some entirely new (Annex 2). Other former logging or farmers' roads are abandoned and blocked such as to facilitate the surveillance. All roads within plantation boundaries are constructed and maintained by Form Ghana. Form Ghana maintains one entry access road into the reserves with controlled access to minimise any illegal activities within the Forest Reserves.

3.2 Plantation structure

In 2008, Form Ghana obtained a lease for the compartments 1-13, 27 and 28 in Asubima Forest Reserve from the Forestry Commission, for the duration of 50 years and renewable. In 2010, compartments 8, 19-22, 27, 28 and 33-35 of Afrensu Brohuma Forest Reserve were allotted to Form Ghana, followed by compartments 12, 29 and 32 in 2012. Compartments were selected on the basis of availability. Each compartment is 1600m x 800m.

Form Ghana defined its own plantation structure based on stands, 16ha quadrants and hectare blocks. Stands are homogeneous management areas, unique in forest type, plant year and location. Stands are subdivided in quadrants. Quadrants are square areas of 16 ha, enclosed by strips of 4m wide skid trails. Each quadrant consists of 16 blocks of 1 ha (hectare blocks).

Stands are named according to the tree species planted and the plant year. For example: Teak 2001, Teak 2008, or Terminalia 2010. Management regimes are defined in principle per stand. In case tree growth is very heterogeneous within a stand, different areas within the stand will be managed according to different regimes. An exception are the stands of natural forests or areas planted with indigenous trees. Natural forest stands and buffer zones will not be harvested.

All hectare blocks are numbered systematically with unique codes. Each unique code consists of a quadrant number, hectare block letter and tree species + plant year. Example: "1A – Teak 2001" stands for "quadrant 1, hectare block A, Teak planted in 2001". Attribution of letters to hectare blocks in a quadrant is done starting from the north-west corner of the quadrant, filling the quadrant up east and southwards.

3.3 Organisational structure

In Akumadan, Form Ghana has a work force that consists of up to 400 people. The number varies with the season as the seasonal weeding and pruning work makes it necessary to attract extra people. Form Ghana is managed by the Managing Director, with a Forest Manager overseeing forest management across the two forest reserves under Form Ghana's control. The Akumadan site is managed by a team consisting of a plantation manager, a forester, supervisors, a head of security, storekeeper, a nurse and mechanics. These in turn direct teams or team leaders who are each responsible for a team. The organogram of the organisation can be found in Annexure 3.

4 SUSTAINABILTY CONCEPT

Both Asubima and Afrensu Brohuma Forest Reserve have been declared ‘degraded’ by the Forestry Commission before Form Ghana started their activities. The original dry deciduous forest has changed into a mosaic of agriculture and savannah. Many of the plants and animals typical for the original dry deciduous forest type had disappeared from the Forest Reserve areas.

Forest reserves were originally established by the national government of Ghana to secure a sustainable timber supply. Extraction of timber was allowed but strictly regulated. Unfortunately, most forest reserves are now degraded due to illegal activities. Therefore, the government installed a policy in the 1990’s to actively restore the ecological, social and economic values of the degraded forest reserves, allocating some forest reserves for strict ecological conservation, with heavily degraded reserves being allocation for strategic national timber production. International investors were attracted for reforestation and restoration of the reserves. Form Ghana operates within this framework for the restoration of strategic timber production in Asubima, Afrensu Brohuma and Taun II forest reserves, also providing rural social upliftment and conservation benefits in areas deemed either sensitive or critical for the provision of ecosystem services

Form Ghana plants high quality timber trees in the degraded forest reserves and manages the natural riparian forest. The main tree species planted on the plantation is teak (*Tectona grandis*), with a maximum cover of 90%. The remaining 10% of the plantation is planted with a mixture of indigenous species.

Form Ghana aims to contribute significantly to the environment and to the Ghanaian economy and to the livelihoods of communities in the direct vicinity of the company. The sustainability concept designed by Form Ghana is a unique tool to ensure responsible management in all pillars of sustainability: society, environment and economy. This concept is applied to all the plantation units managed by Form Ghana.

4.1 Economical sustainability

Form Ghana aims at the long-term production of high-quality timber, thereby meeting the steady national and global demand for sustainable roundwood. Since the remaining natural forests in Ghana are in a deplorable state, plantation forests will become even more critical to meet this demand in future. To bridge the time until the first harvest of roundwood, expected in 2027, Form Ghana generates income from carbon credits sales and commercial thinning.

The uneven age character of the plantation due to annual planting will assure periodical revenues from sales of forest products from the Teak areas and provision of ecosystem services from the indigenous forest areas. Harvesting of the teak areas will be distributed over a sustainable harvesting regime during the first rotation of felling to ensure a more even spread of harvesting and revenue generation.

4.2 Ecological sustainability

Form Ghana believes that the mixture of teak, various native tree species and buffer zones is beneficial for the restoration of ecological and economic values of the forest reserve. Restoration of the tree cover will create a forest climate where carbon is stored above and below-ground, nutrient cycles are restored and water quality is improved. Form Ghana plants the teak trees mainly on deep, fertile and level soils that are relatively insensitive to erosion. Buffer zones or ecologically valuable areas are preferably planted with indigenous species. Erosion is therefore limited to an absolute minimum.

Corridors of natural, riparian forest, “buffer zones”, are established alongside water bodies to create habitats for flora, birds and wildlife. Buffer zones break the teak monoculture stands and

are specifically designed for biodiversity conservation. The buffer vegetation will develop into a network of mixed native vegetation, providing corridors and refugia of suitable habitat for native flora and fauna. Birds and other wildlife will help plants and trees to spread their seeds, further enhancing vegetation cover (see Parotta, 1992). Organic matter and water retention capacity of the soil will be restored when fungi, bacteria and micro fauna recover their natural balance (Montagnini, 2001).

The buffer zones also function as green belts for fire protection. Buffer zones are suitable for fire control because of the moist nature of the riparian forests (Pettit and Naiman, 2007).

Form Ghana makes no use of genetically modified (GMO) planting material of any kind and will introduce no new species into the area, in order to avoid introducing pests or invasive species.

As part of Form Ghana's sustainability policy, chemical use in the plantation is maintained at a minimum. Mechanical weeding is preferred to chemical weeding but before the canopy is closed this method is very costly and not effective enough by itself. Further to this many invasive exotic species require chemical control in the initial phases of weed eradication. Therefore, in addition to mechanical weeding, herbicides are used during land preparation to control regrowth of weeds and eradicate remaining stumps of York and Teak. After canopy closure, herbicides are no longer used. One type of insecticide and one type of fungicide are used in the nursery when necessary. Form has specific internal protocols for the use and storage of these chemicals.

For both Asubima and Afrensu Brohuma Forest Reserves, a High Conservation Value Forest (HCVF) analysis was conducted. HCVF is a natural forest with environmental, socioeconomic, biodiversity or landscape value, as used within forestry management certification systems (en.wikipedia.org). It was concluded that both forest reserves are highly degraded and cannot be classified as high conservation value forests. Ongoing High Conservation Value (HCV) Assessments are conducted every five years to assess and update these assessments based on ongoing monitoring and periodic biodiversity assessment. Results of these assessments are available on the Form Ghana website (https://www.formghana.com/hcvf-analyses).

4.3 Social sustainability

Labour conditions for Form Ghana employees naturally comply with national legislation and meet all FSC™ standards. The First Aid Procedures & Emergency Evacuation Protocol (P8) provides guidelines for ensuring health and safety of all Form Ghana employees. Form Ghana has developed good relations with the surrounding communities and will continue to maintain them. In the benefit sharing agreement accompanying the land lease, it is officially laid down how the community benefits from Form Ghana's activities. Form Ghana developed their own social plan describing how Form Ghana deals with employment, training of personnel, intercropping and extension services (see chapter 12). The collaboration with surrounding communities and local farmers is evaluated every year and if necessary, adjusted to meet the social goals of Form Ghana.

Although farming is not allowed within forest reserves according to Ghana's national law, there were many smallholders farms in Asubima and Afrensu Brohuma when Form Ghana started their activities in 2007. Form Ghana gives these farmers the opportunity to sign an intercropping agreement with the company, enabling them to farm legally in between the young teak trees. This benefits the farmers but also the company because the farmers weed around the young teak trees, promoting their growth. After every final felling, land will become available intercropping.

The collection of Non-Timber Forest Products (NTFPs) is restricted to allow regeneration of the severely degraded natural forest areas of Asubima and Afrensu Brohuma FR. Harvesting

of locally rare materials such as rattan is prohibited until these species have increased their stocking. Fruits and nuts can be collected freely.

The integration of social sustainability in Form Ghana's management is documented in Form Ghana's Corporate Social Responsibility policy that can be uploaded from the website (**Error! Hyperlink reference not valid.**).

5 PLANTATION MANAGEMENT

Planting in Asubima FR started in 2001 and finished in 2012. The area that was planted was a pilot project of ca. 53.13 ha in 2001 in Asubima Forest Reserve. Planting continued in Asubima and Afrensu Brohuma FR in the period 2008 – 2012. A total area of 3446.22 ha has been planted in both forest reserves (2929.87 teak and 502.17 ha of indigenous). The total area of the both reserves also contains some natural areas (14.19 Ha), and all together covers 3446,22 ha.

In Asubima Forest Reserve, 84.9% of the planted area was planted with teak and 15.1% with indigenous tree species, or left for natural regeneration. In Afrensu Brohuma, 85.1% was teak and 14.9% indigenous. Teak was planted on the best quality sites, selected based on research by the Soil Research Institute in Kumasi (CSIR). Characteristics are:

- pH > 5
- Soils depth > 1.20m (4 ft)
- Good drainage
- Flat to slightly undulating surface to avoid erosion of the topsoil
- High soil fertility

In areas deemed to have conservation potential, a mix of indigenous species was planted. Buffer vegetation was conserved and/or enhanced in 30m strips alongside rivers and water bodies.

The management objectives can be summarised as follows:

1. Establishment and management of sustainable timber plantations;
2. Conservation and regeneration of natural riparian forest in accordance with the land lease requirements and relevant national legislation;
3. Generate sustainable income from round-wood and carbon sequestration;
4. Provide social benefits for employees and surrounding communities.

Current land use is described in table 2 below.

Planted Areas	Area Planted Per Reserve (Ha)	Year (Ha)	Total Area (Ha)	Indigenous (Ha)	Teak (Ha)	Natural (Ha)
ASUBIMA	1,668.63	**2001**	**245.69**	192.56	53.13	
		2006	**65.10**		65.10	
		2008	**225.00**		225.00	
		2009	**512.20**		511.66	0.54
		2010	**595.77**	47.68	538.33	9.75
		2012	**24.88**		24.88	
AFRENSU BROHUMA	1,777.59	**2011**	**1,030.96**	181.48	845.57	3.90
		2012	**746.64**	80.43	666.20	
TOTAL - AKUMADAN			**3,446.22**	**502.17**	**2,929.87**	**14.19**

Table 2: Land area allocation by land use and year of restoration activity commencement.

5.1 Teak: justification of plantation species

Teak (*Tectona grandis*) is the principal species planted by Form Ghana. Because of the physical and aesthetic qualities of teak wood, it is a much-desired timber species with a good commercial value. The production of teak has been successfully adopted in West Africa, with a better economic performance than indigenous tree species and other exotic species

(Maldonado and Louppe, 2000; Dupuy and Verhaegen, 1993; Keogh and Pentsil, 2001; Behaghel, 1999). The price of Teak can be more than €300/m3 for saw logs. For plantation saw logs of Wawa (Triplochiton scleroxylon) or Ofram (Terminalia superba), this price is around €50/m³. With an unrivalled growth rate of 14 m3/yr/ha, teak is currently the only commercially viable option.

Teak silviculture has been practiced since the 19th century (Behaghel, 1999). This long history of experience with teak silviculture resulted in elaborate management guidelines and accurate yield prognoses, providing a solid technical basis for plantation establishment today. There is a number of risks associated with plantation establishment, e.g. erosion, invasive species, pests and diseases. How these risks are dealt with by Form Ghana is discussed below.

As an exotic tree species in Ghana, teak is less prone to diseases than local species. Disease risk is further reduced by selecting proper sites for plantation establishment, where tree health is good (Keogh and Pentsil, 2001). Therefore, no chemical treatments are required for pest control. More information on pests and diseases is provided in section 7.3.

The risk of teak spreading outside of the plantation is low because of two reasons: 1) the dispersal capacity of the teak seeds is limited, and 2) teak is a light demanding species so it cannot invade the densely vegetated grasslands surrounding the Forest Reserves. Buffer zones and fire strips around the plantation further inhibit the spread of teak outside plantation boundaries. Most areas surrounding the plantation are in agricultural use for which teak poses no threat.

5.2 Teak provenances

The pilot area was planted with a selected teak provenance from plus trees from Bouaké in Ivory Coast, studied and managed by CTFT, Cirad and Sodefor. This provenance shows excellent growth and vigour in Ghana.

Teak was first introduced to the Bouaké region of central Ivory Coast (Bamoro, Matiemba, Kokondekro and Bennafoko localities) in 1929, in the savannah-forest transitional zone (Maldonado and Louppe, 2000; Dupuy, 1990). Genetic research showed that provenances from Ivory Coast are closely related to the Indian provenances Virnoli and Nilambur (Kerala) (Verhaegen, 1989 in Dupuy and Verhaegen, 1993). Provenance performance can be assessed according to a number of tree characteristics. Keiding et al. (1986) found that for semi-moist to dry regions of West Africa, Indian provenances score best on three performance indices: quality, health and growth. Bouaké teak shows vigorous growth (Kadio, 1990 in Dupuy and Verhaegen, 1993), good aesthetic quality (Durand, 1984 in Maldonado and Louppe, 2000) and medium to good wood quality (Dupuy and Verhaegen, 1993).

In order to broaden the genetic base and to profit from selection work done on other areas, Form Ghana also planted teak from Sangoué (Oumé) in Ivory Coast and clones from Brazil. From these sources the best quality seeds and cuttings have been procured to establish test blocks within the plantation.

5.3 Indigenous tree species

A number of indigenous species were planted in mixed stands in areas of conservation potential and in the buffer zones along rivers (Table 5.1). All species are chosen based on extensive experience of Form Ghana with projects in Ivory Coast, Cameroon and Ghana.

Table 5.1. *Local species planted by Form Ghana*

Local name	Scientific name
Awiemfosamina	*Albizia ferruginea*
Bombax	*Rhodognaphalon brevicuspe*
Bonsamdua	*Distemonantus benthamianus*

Emeri*	*Terminalia ivorense*
Kokrodua	*Pericopsis elata*
Kusia	*Nauclea diderrichii*
Mahogany	*Khaya anthotheca*
Mansonia	*Mansonia altissima*
Ofram*	*Terminalia superba*
Onyina	*Ceiba pentandra*
Potrodom	*Erythrophleum ivorense*
Watapuo	*Cola gigantea*
Wawa*	*Triplochiton scleroxylon*

** Fast growing species*

As part of biodiversity conservation, all trees with >20cm DBH are protected and left to grow, even within the areas allocated for teak plantation blocks.

5.4 Buffer zones

Form Ghana strives to conserve vegetation strips of at least 30m on each side of rivers and streams. These “buffer zones” are restoring back to natural forest. In some areas of the buffer zones the stocking of trees was low, or trees were completely absent. In order to assist natural restoration of these areas, Form Ghana planted indigenous trees. The local species originate from Ghana and are in most cases locally sourced in order to maintain the genetic integrity of the local forests. This happened in collaboration with the Forestry Research Institute of Ghana (FORIG). No harvesting is permitted in the buffer zones.

Invasive weeds hampering the natural forest restoration are removed. The main weeds are the tree species *Broussonetia paperifera.* (York), the shrub *Chromolaena odorata* (Akyeampong) and several grass species of which *Penisetum purpureum* (Elephant grass) is most abundant.

In total, the buffer zones cover a surface of 222ha which is equivalent to 13% of the total area under management by Form Ghana (Annex 2).

5.5 Environment

Continuous overexploitation and wildfire attacks have taken their toll over the past decades in Asubima and Afrensu Brohuma Forest Reserves prior to Form Ghana assuming control over these areas: plant communities have changed dramatically from dense forest vegetation to savannah grasslands and degraded agricultural land, wildlife declined in numbers and savannah birds thrive at the cost of those birds characteristic for the forest.

Despite these drastic changes, a number of birds, mammals and reptiles still remain, as well as a few indigenous trees. Form Ghana intends to conserve remnant trees and enhance remaining wildlife populations by creating habitat in buffer zones and by controlling all hunting and poaching activities. By reforesting the land, Form Ghana expects to restore many of the ecosystem functions that were degraded or absent. The focus of environmental management is on managing biodiversity, water and soil.

The Social and Environmental Impact Assessments conducted for both forest reserves foresaw many positive effects of Form Ghana’s reforestation activities on biodiversity, soils, hydrology, local climate and carbon balance. Form Ghana manages their forest plantation in such a way that these positive impacts are optimised and negative impacts are avoided or mitigated. The 2021 Biodiversity study has confirmed the effectiveness and efficiency of management strategies and activities, recommending that these activities be maintained to continue to enhance these positive effects.

New insights on local ecology, biodiversity or other environmental factors that arise from monitoring will be used to modify strategies for conservation purposes when necessary.

5.6 Water and soil

As part of the SEIA, water quality before plantation establishment was determined in Asubima FR. This study showed severe deterioration of several quality parameters (Abeney et al., 2008). Form Ghana intends to improve water quality, quantity and aquatic ecology by the establishment of buffer zones along the water bodies. These buffer zones minimise the impact of plantation establishment on aquatic ecology.

Form Ghana takes precautions to prevent erosion, soil acidification, soil fertility loss and pollution with agro-chemicals. Best practise guidelines are closely followed for plantation establishment, forest management, road construction, soil fertility management and pollution control. Dead wood, dry leaves and crown biomass resulting from thinning, felling and pruning are left in the plantation to maintain and enhance soil fertility.

5.7 Social management

The purpose of the social plan is to share the benefits of Form Ghana with stakeholders and to safeguard their rights. Stakeholder meetings are held 3 times a year with traditional landowners, farmers, NGOs, Forestry Commission members and Form Ghana representatives, as described in Protocol 6. Form Ghana's conflict management procedure is described in Protocol 7.

People living close to the plantation are gives priority with the employment of skilled and unskilled workers. Majority of Form Ghana employees are from the fringe communities. Table 5.2 shows the numerical strength of Form Ghana as at the end of 2021. These numbers increase depending on the season and activities that need to be carried out such pruning, firefighting etc. All workers are employed under the national labour standards for the agricultural sector and the ILO standards. Personnel is trained according to Protocol 11. Up to three young forestry graduates are engaged to be trained in advanced nursery and plantation techniques. These forestry engineers will promote reforestation in the region and train local landowners in forest plantation practices and nursery establishment and maintenance. There are several protocols and policies governing Form Ghana's human resource management including the Complaint Response Mechanism, Gender Policy and Harassment Policy to ensure that Form Ghana meet international expectations for management of people.

Farmers can sign an intercropping agreement with Form Ghana to plant their crops between the young teak seedlings. Restrictions apply to the type of crop, use of fertilizers and phyto-sanitary agents and the distance between the crops and the planted trees. The opportunity for intercropping is open for everyone and offered an intercropping agreement for 1 year, with the possibility for renewal. The location and size of the farmland is often determined by blocks earmarked for developed by Form Ghana. No restriction is placed for the farm size however, consideration is given to all farmers who expressed interest by filling the intercropping agreement form. The project management will maintain its full right to remove any intercropping farmers from the plantation if they do not respect the agreement.

Table 5.2. Numerical strength of Akumadan plantations

	Male	Female	Total
Permanent	125	48	173
Casual	78	95	173
Total	**203**	**143**	**346**

5.8 Monitoring and evaluation

Form Ghana commits itself to different types of monitoring: Biodiversity, Forest Condition, Water Quality, Forest Production, Economic Aspects and Social Benefits. Applied methods of

monitoring depend on the purpose of each monitoring activity. These methods are described in protocol 13, per monitoring type.

Every year, a monitoring plan is constructed by Form Ghana with analysis by external consultants, including all monitoring activities that are expected for that year. Included in the monitoring plan is a list of indicators and verifiers that Form Ghana adheres to. In addition, Form Ghana or an external consultant analyses the monitoring data on forest condition, measured in permanent sample plots (PSPs). These analyses are recorded in an annual PSP Monitoring Report. All other monitoring activities are recorded in an annual Monitoring Report. Results from the monitoring activities are processed and used as input to improve Form Ghana's management.

6 OPERATIONAL MANAGEMENT

6.1 Silvicultural system

Form Ghana developed their silvicultural system based on tree species, performance and on the desired end product. Form Ghana aims at the production of high-quality teak saw logs, because of the high revenue prospects. A 20-year rotation cycle for teak was chosen to match this aim. For the indigenous tree species, a suitable rotation length is determined per species. In some areas the trees will not be felled (buffer zones). The system applied by Form Ghana requires intensive plantation management, which is implemented according to best practice.

Thinning regime and harvest estimates are based on yield tables from teak plantations in Ivory Coast, where similar soil and climatic conditions apply. These tables provide growth data over a period of 20 years, based on a specific management regime, including thinning and final felling (Annex 5). The tables are divided in four realistic yield classes based on the dominant height[1] (H_{dom}) of a stand. The difference between the yield classes in total production potential and mean annual increment is considerable (Table 6.1).

Table 6.1. *Yield classes from Ivory Coast with main characteristics*

Yield class*	H_{dom} (m after 20 years)	Total production (m^3 after 20 years)	Mean annual increment (m^3/ha/y)
1	28.0	350.3	17.5
2	24.9	283.9	14.2
3	21.8	201.0	10.1
4	18.7	153.8	7.7

**The classes are based on an initial planting density of 1111 plants/ha., a 20-year rotation, and 2-4 thinnings before final felling.*

It is essential that the Form Ghana tree stands are classified accurately according to their yield class. This categorization is done based on results from growth performance monitoring in Permanent Sample Plots (PSPs), as described in protocol 13. The expected average yield class for Asubima and Afrensu Brohuma FR is class two. This expectation is actualized regularly with results from an intensive monitoring program.

The thinning regime suggested for yield class two consists of three thinnings and a final harvest. The first thinning is non-commercial. The expected volumes of the commercial thinnings and the final harvest according to the yield tables are presented in table 6.2.

Table 6.2. *Expected harvestable volumes of Teak from the Asubima FR plantation*

Planting year	Surface (ha)	Yield 14 yrs (thinning) m^3	Yield 20 yrs (clear cut) m^3	Total yield
2001	53		7,155	7,155
2006	65	1,625	8,125	9,750
2008	225	7,250	39,150	24,825
2009	511	12,792	69,074	124,132
2010	538	13,458	72,675	246,590
2011	846	21,139	114,152	246,590
2012	691	17,277	93,296	246,590
Total	2,929	71,916	388,346	895,882

[1] *Dominant height is estimated by the average height of the five trees with the largest diameter in a permanent sample plot.*

Harvestable volumes are calculated with values from the yield table of yield class 2 (Annex 4). Commercial thinning volumes are approximately 40m^3/ha, final harvested volume is 207m^3/ha, total 247 m^3/ha. Assumed in this table is that 90% of the plantation area will be planted with Teak.

The tables are used as a calculation and estimation tool for plantation management. As soon as the plantation has reached an age at which enough data is available, Form Ghana intends to create their own yield table starting in 2022 with specialist input.

6.2 Nursery system

Form Ghana established a tree nursery close to the plantation site (Figure 4). All Form Ghana planting stock is produced in this own nursery. There are three shaded irrigation sheds with sprinkling installations and six hectares of beds reserved for stump production, irrigated with sprinklers. Water for irrigation is pumped up from a dammed creek close to the nursery. The nursery is designed to facilitate cultivation of teak and several species of indigenous trees. Detailed nursery management is described in protocol 14.

Native tree species are mostly grown from seeds in poly pots. The nursery is equipped with greenhouses for treating seeds in order to break dormancy. As soon as germination starts, plantlets are pricked out and transferred to prepared poly pots in shaded irrigation sheds.

Teak is grown in two different ways:

- Stump production
- Cloning

Stump production is the main nursery practice for teak. For the production of stumps, seeds are sown directly in the field during the dry season (January-February). When the planting season starts in April, the seedlings are uprooted and pruned, to form stumps that can directly be planted in the field.

Teak clones are produced from cuttings, planted in Non-Mist Propagators (NMPs). When rooted, the clones are transferred to polypots and after a period of 3 weeks, they are taken out of the NMP and transferred to specially prepared beds under shade netting.

Figure 3. *Nursery impression with shaded irrigation sheds and NMPs.*

Form Ghana retrieves high quality teak seeds from an Ivory Coast provenance that was planted in the pilot plantation in Asubima Forest Reserve. All planting material is therefore of

high genetic and phenotypic quality and selected to suit the local conditions. In future, other good sites for seed harvest will be selected and managed as seed stands. Seeds for indigenous tree species are collected on the plantation as much as possible.

6.3 Silvicultural operations

This section summarizes the silvicultural operations applied by Form Ghana and the rationale behind them. Detailed technical plantation management procedures are outlined in protocol 15.

6.3.1 Terrain preparation

The soil is prepared for planting between January and April to create optimal conditions for the seedlings. The area to be planted is ploughed and sprayed with FSC™ permitted herbicides if necessary. At this moment, Form Ghana does not apply soil fertility management. However, if soil monitoring results indicate that soil fertility declines, Form Ghana will take appropriate action.

6.3.2 Plantation establishment

Teak trees are planted at a density of 1111 trees/ha (3x3m) on most of the plantation. The 2008 tree stand is an exception, with a plant density of 1667 trees/ha (2x3). This higher density was chosen because the quality of the planting material was unknown. In future, a planting density of 3x3 will be maintained.

Planting takes place between April and June, starting in the second half of April when the rainy season has really set in, to avoid the risk of drought stress.

6.3.3 Silvicultural treatments

After planting, beating up is the first operation to be done. Beating up improves stocking to increase efficiency, improves weed control because of early canopy closure, increase carbon storage and make better use of the land in general. The young trees are then singled to direct growth at an early stage, reducing efforts later on.

Before canopy closure, weeding is needed to prevent weeds from competing with the seedlings. Climbers are cut to prevent the planted stock from growing crooked or being smothered. Forest stands are checked every year to determine whether climber cutting is necessary. Only if this is the case the climber cutting is carried out.

Wood distribution between stem and branches can be influenced by thinning and pruning. By timely thinning and pruning, the trees can be directed to have optimal height growth and well-formed crowns, with little biomass wasted on side branches in early life stages.

Pruning is undertaken mainly to clean part of the stem from branches, which leads to higher timber quality and better processing

6.3.4 Final harvesting

After 20 years, all remaining trees are harvested. This may change depending on market development. Establishment of the new plantation will be done by planting new seedlings/stumps, not through coppicing. Therefore, the terrain preparation section above will apply for all rotation cycles to come.

6.3.5 Maintaining the positive effects of plantation establishment

To safeguard against the potential significant reversal of the accrued environmental and climate change benefits from forest restoration, the following activities are important:

i) minimizing fire risks;
ii) no harvesting of trees in the restored buffer zones;
iii) avoiding erosion and pollution during harvesting

iv) ensuring a timely replanting after the final harvest
v) A mosaic of buffer-zones and indigenous plantation will ensure that key parts of the forest land scape remain in place.

7 RISK MANAGEMENT

7.1 Prevention of illegal activities

Form Ghana is determined to prevent illegal activities, e.g. intrusion, hunting, trapping, felling, burning, planting food crop without Form Ghana's consent, from taking place on the plantation. Protocol 2 describes the different ways Form Ghana adopts to realize this goal.

7.2 Fire management

Fire is the greatest risk for the plantation. Mature teak can withstand some fire but young plants are not yet resistant. Most of the native forest species cannot withstand fire at all. Fire management is employed to reduce fire risk, focusing on four main axes: fuel load reduction, fire breaks, establishment and training of a fire squad, and awareness raising on the risks of fire for local people. The detailed fire procedures are described in Protocol 21.

7.3 Control of pests and diseases

Pests can cause considerable damage to forest plantations, especially monocultures. It is therefore of great importance to prevent diseases from entering the plantation and to take quick and appropriate action if a disease has been identified.

Teak, an exotic species in Ghana, is not very susceptible to pests and diseases (Gibson, 1975). Stem rot occurs occasionally in Ghana (Keogh and Pentsil, 2001). A number of fungi that cause white and brown rot in West Africa were listed by Gibson (1975). Form Ghana reduces the risk of these infections by planting teak only on appropriate sites, keeping a healthy nutrient balance and preventing damage from fire, pruning or harvesting (Keogh and Pentsil, 2001).

There are some pathogens and insects known to affect indigenous species. Infection and attacks can be avoided by planting a mixture of different species and abiding by proper hygiene measures, especially in the nursery. In some cases, pesticide may be needed to protect the crop. This will only be used as a last resort because pesticides are costly and may damage the environment.

Termites can be a problem for some of the tree species. However, since termites are important in keeping the soil open and fertile no action will be taken against them.

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Annex 1. List of Protocols and Policies

Legislation and document management

- **P 01 Follow-up of Legislation and Conventions**
  This document describes how Form Ghana follows up on new legal texts that appear in Ghana and new conventions that are signed internationally. It also describes how texts are evaluated for applicability to Form Ghana.
- **P 02 Security**
  This document describes how Form Ghana avoid illegal activities on the lands it manages.
- **P 03 Periodical Review of Documentation**
  This document describes the system of annual evaluation of all management documents to include new information and assure continued relevance and actuality.

Waste management and environmental protection

- **P 04A & B Waste Management**
  This document describes how Form Ghana deals with waste produced on its various sites.
- **P 05 Responsible Use of Pesticides**
  This document prescribes how pesticides need to be handled. It also describes the necessary safety measures.
- **P 16A & B Storage of Fuel, Lubricants and Toxins**
  This document prescribes how hazardous substances must be handled and stored across the two sites.
- **P 18 Machine Maintenance**
  This document prescribes maintenance of machines to assure their continued functioning.

Stakeholder engagement

- **P 06A & B Stakeholder Management**
  This document describes how personnel and the local population are informed on Form Ghana activities, and how stakeholders can engage with Form Ghana across the various sites of operation
- **P 07 Complaint Response Mechanism**
  This document describes how grievances are dealt with and how grievances are redressed.
- **Resettlement Action Plan**
  This document describes the resettlement activities that Form Ghana undertakes for people that need as a consequence of Form Ghana activities.
- **P28A & B Community Development**
  This plan describes the community development activities that Form Ghana undertakes across the two sites.
- **P 30 Intercropping**
  This document describes Form Ghana's approach to intercropping farmers.

Health and safety management

- **P 08A & B First Aid Procedures & Emergency Evacuation**
  This document prescribes how to deal with cases of emergency across the two sites.
- **P 09 Transport**

This document prescribes how personnel can be transported.

- **P 10A & B Personal Protection**
  This document assesses the risks related to the various work places and prescribes the safety gear people need for various jobs.
- **P 23 Envenomation by snakes and insects**
  This document describes the possible snakes and insects that may harm people and how to act in case of bites and stings.
- **P 27 Information on Contagious Diseases**
  This document serves as a basis for sensitization on contagious diseases.

Personnel management and training

- **P 11 Training of Personnel**
  This document presents the general recurrent planning for training
- **P 17 Management Requirements Responsibilities Senior Staff**
  This document describes the capacities need for senior functions
- **P 20 Meeting Schedule**
  This document describes the management meetings
- **Training register**
  This document is an up-to-date list of training provided to all workers

Certification management

- **P 12 Internal Audits**
  This document prescribes internal audits to be conducted at Form Ghana to assure the continued high level of performance at the company.
- **P 22 Chain of Custody**
  This document describes the system of tracking and tracing of logs and timber at the company.
- **P 19 FSC™ Logo Usage**
  This document prescribes how the FSC™ logo can be used by the company.

Technical work prescriptions

- **P 14A & B Technical Performance in the Nursery**
  This document describes all the activities in the two nurseries and presents quality standards
- **P 15 Technical Performance in the Plantation**
  This document describes all the activities in the plantation and presents quality standards
- **P 21A & B Fire Prevention and Fire-fighting**
  This document describes how fires will be prevented and when needed combatted across the two sites.
- **P 24 Road Construction and Maintenance**
  This document prescribes how roads are to be constructed and maintained.
- **P 25 Harvesting**
  This document describes the system for extracting and preparing logs during forest harvesting.
- **P 29 Integrated Pest Management**
  This procedure describes how to manage pest damage by the most economical means, and with the least possible hazard to people, property, and the environment.

Monitoring

- **P 13A & B Monitoring**
  This protocol describes the various monitoring activities across the two sites
- **Monitoring Plan**
  This document describes the planning of the various monitoring activities

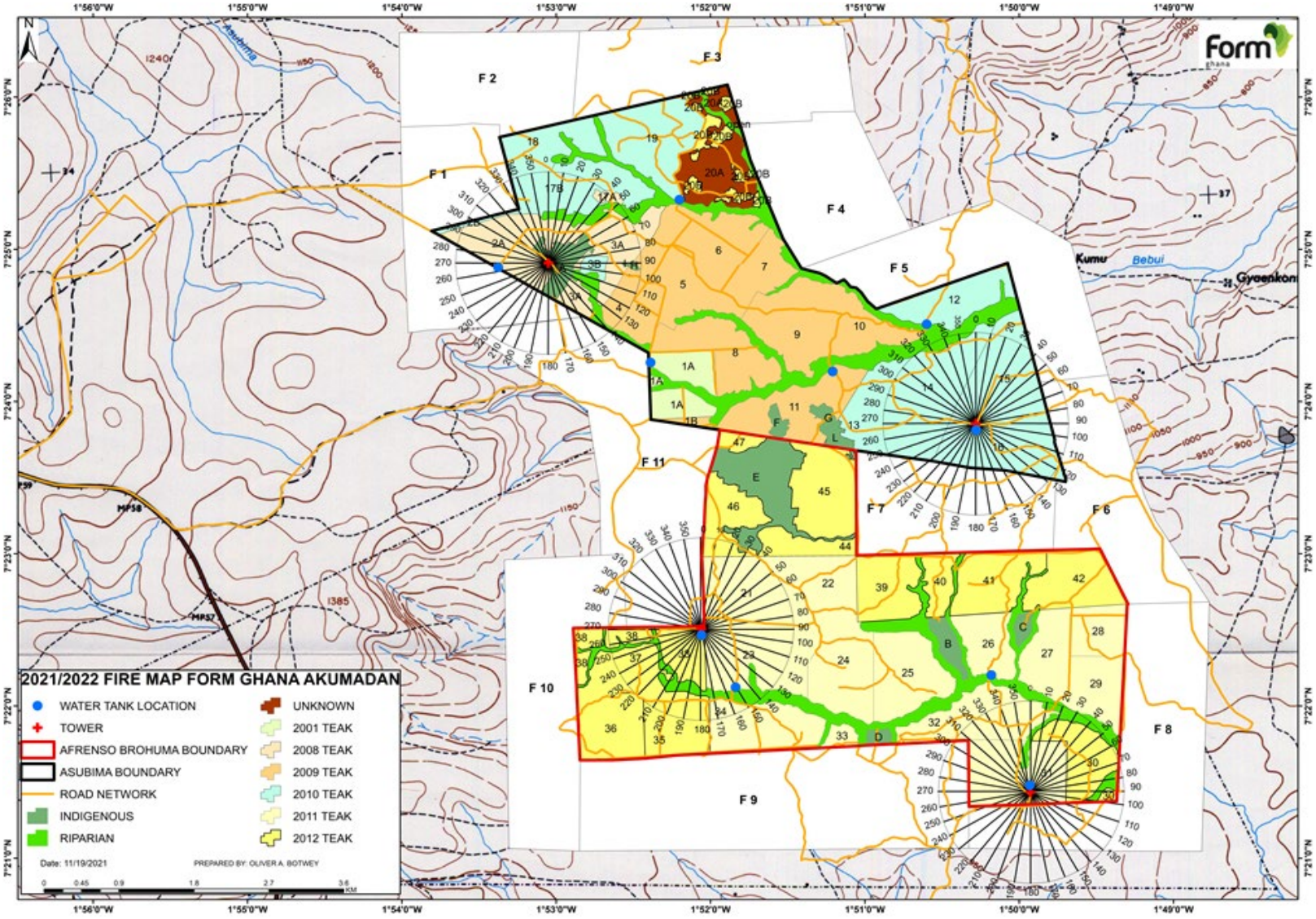
Human resources policies, procedures and labour relations.

Form Ghana HR department has developed a number of policies and procedures in addition to the protocols which are part of the Environmental and Social Management Plans (ESMP). These include:

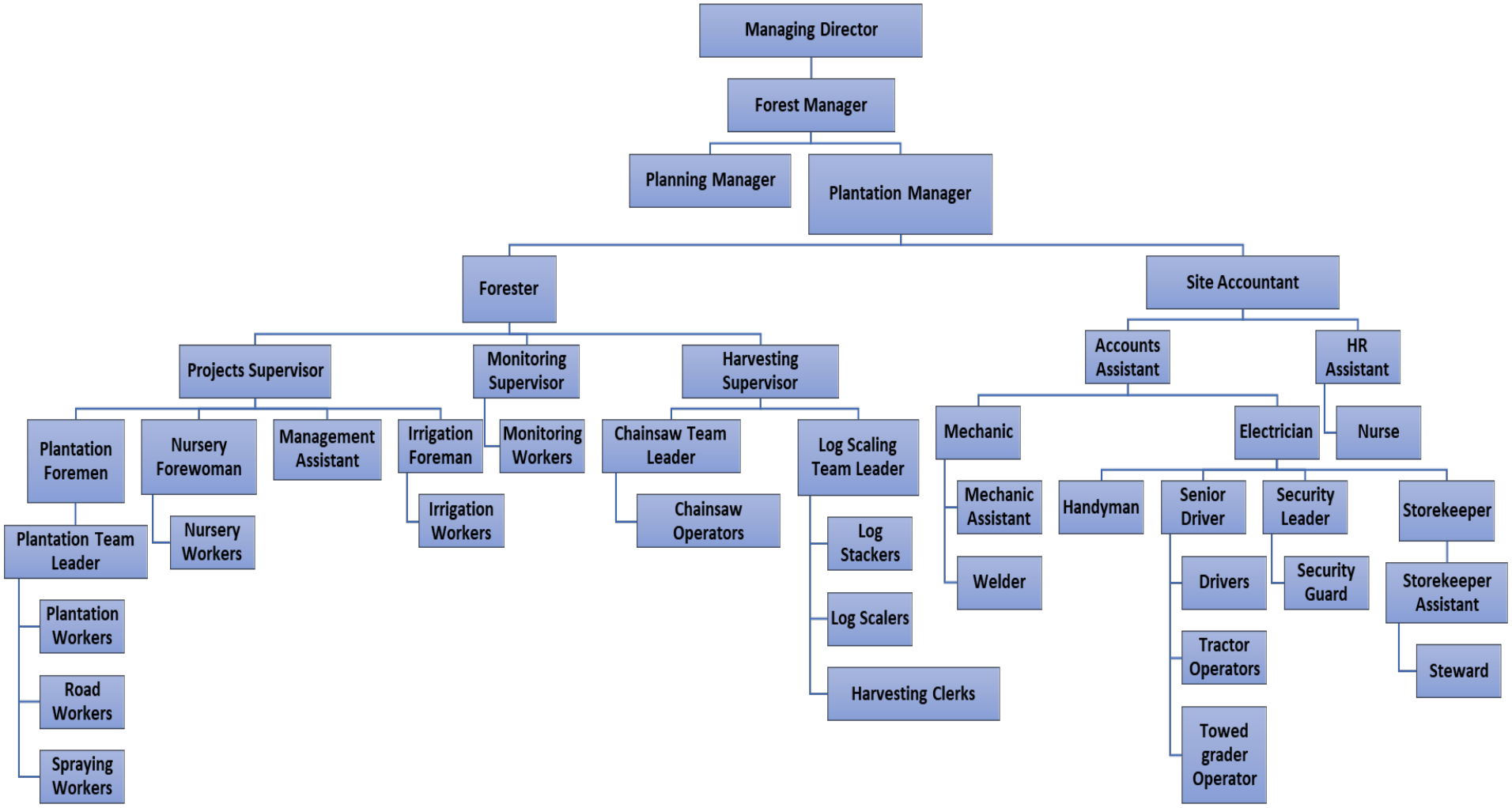
- **Absenteeism Management Policy** which serves as a guidance to implement rules and regulation governing the company to maximize employee attendance at work.
- **FG Visitor's Emergency form** (linked to Protocol 27) which informs visitors of necessary medical precautions and collects emergency information.
- **HEALTHCARE POLICY 1 update** sets out principles and procedures so as to create and promote best service of healthcare to all employees.
- **HIV/AIDS Policy** is to ensure a consistent and equitable approach to the prevention of HIV/AIDS among employees and their families, and to the management of the consequences of HIV Aids, including the care and support of employees living with HIV/AIDS.
- **Industrial Attachment Policy** is a training program designed to enable students/graduates placed with the company to acquire practical technical skills and knowledge through on-the-job training under the mentorship of company supervisors with vast experiences in forest rehabilitation for development.
- **Internal Rules and Regulations FMGH** presents the general rules relating to Employment, Discipline, Sanctions, Provisions as to the rights and defence of the workers
- **LEAVE POLICY** seeks to allow flexibility for employees to meet personal, family, work and community commitments without compromising the achievements of business objectives.
- **LETTERHEAD USE POLICY** describes officially the rules and regulations governing the use of company's letterhead, logo and stamp.
- **RECRUITMENT POLICY AND PROCEDURES** aims at enabling the company find and recruit people with the necessary qualifications, skills, and expertise to deliver on its strategic objectives and goals.
- **SHORT TERM- Workers** policy seeks to reach and promote decent work irrespective of employment arrangement, Form Ghana has formulated principles and procedures. These principles and procedures, in conjunction with Form Ghana's internal rules and regulations, grievance protocol and disciplinary action policy, will ensure good labour standards and protection of workers employed by Form Ghana.
- **TRAINING AND DEVELOPMENT POLICY** is to notify Form Ghana employees of the ways and means of training and developing workers that have the skills needed or career path.
- **Company Procedure Appendix 2019** informs on phone numbers and allowances
- **Procedure Manual Update 2019** describes part of the company's procedures.
- **Section 3 – Finance** explains financial rules
- **Section 4 – Accommodation & Car Policy** describes some of the benefits of FG workers.
- **Section 5- Communication** lays out the rules for communication efforts by the company.
- **Section 6 - IT Policy** regulates the use of the company's IT equipment and services.

- **Section 7- Human Resource Management** describes the HR management of Form Ghana.
- **Section 8 - Gender Policy** formulates principles and procedures that address the need for gender equality, rights, responsibilities and opportunities for all employees of the company.

Annex 2. FG plantations in Asubima and Afrensu Brohuma



Annex 3. Organisational structure of Form Ghana Akumadan



Annex 4. Yield tables for teak from Ivory Coast

Site class 1

Age	N	H dom	D before	D after	G before	G after	% thinning	Volume	Volume thinning
1	1111	3.4	3.5		0			0	
2	1111	6.8	7		4.3			10.2	
3	750	10.2	10.5	11.4	9.6	7.7	20.4	34.6	4.6
4	750	12.2	12.8		9.6			41	
5	750	14.1	15		13.3			65.8	
6	400	15.7	16.4	18.5	15.8	10.8	32.1	100.3	29.3
7	400	16.9	18.3		10.5			71.5	
8	400	18	20.2		12.8			93	
9	400	19.2	22.1		15.3			118.5	
10	250	20.3	24	26.5	18.1	13.8	23.8	150.1	33.1
11	250	21.2	25.7		12.9			111.9	
12	250	22	27.4		14.7			132.2	
13	250	22.9	29		16.6			154.8	
14	250	23.7	30.7		18.5			179.7	
15	165	24.6	32.4	35.3	20.6	16.1	21.7	205.3	40.3
16	165	25.3	34		15			153.7	
17	165	26	35.7		16.5			173.4	
18	165	26.6	37.3		18			194.7	
19	165	27.3	39		19.7			217.6	
20	165	28	40.6	43.3	21.4	24.3	-13.7	243.1	243.1
Total production									**350.3**
Annual increment (m^3/year)									**17.5**

Site class 2

Age	N	H dom	D before	D after	G before	G after	% thinning	Volume	Volume thinning
1	1111	2.8	2.8		0			0	
2	1111	5.5	5.5		2.6			5.2	
3	1111	8.3	7.3		4.7			13.8	
4	750	11	11	12.1	10.6	8.6	18.3	41.5	3.5
5	750	12.6	13.6		10.9			49	
6	750	13.8	14.7		12.7			62.7	
7	750	15	15.8		14.7			78.8	
8	450	16.2	16.9	18.7	16.8	12.4	26.5	109	25
9	450	17.2	18.9		12.6			86.6	
10	450	18.1	20.9		15.4			111.8	
11	450	18.9	21.8		16.8			127	
12	300	19.7	22.7	24.8	18.2	14.5	20.4	143.5	25.5
13	300	20.4	24.3		14			114	
14	300	21.2	26		15.9			134.5	
15	300	21.9	27.6		17.9			157.2	
16	300	22.5	28.4		18.9			170.4	
17	300	23.1	29.1		20			184.4	
18	300	23.7	29.9		21			199	
19	300	24.3	30.6		22.1			214.4	
20	300	24.9	31.3	34.6	23.1			229.9	229.9
Total production									**283.9**
Annual increment (m^3/year)									**14.2**

Site class 3

Age	N	H dom	D before	D after	G before	G after	% thinning	Volume	Volume thinning
1	1111	2.2	2.2		0			0	
2	1111	4.4	4.4		1.7			2.7	
3	1111	6.6	6.6		3.8			9.1	
4	1111	8.8	8.8		6.8			21.6	
5	750	11	11	12.1	10.6	8.6	18.3	42.2	4.2
6	750	12	12.2		8.8			38.3	
7	750	13	13.4		10.6			50	
8	750	14	14.6		12.6			63.9	
9	750	15	15.8		14.7			80.2	
10	450	15.8	16.6	18.3	16.2	11.8	27.1	103.4	13.4
11	450	16.5	17.7		11			73.3	
12	450	17.1	18.8		12.4			85.9	
13	450	17.8	19.8		13.9			99.7	
14	450	18.4	20.9		15.5			115	
15	450	19.1	22		17.1			131.7	
16	300	19.7	22.7	24.7	18.2	14.4	21.1	145.3	27.3
17	300	20.2	23.9		13.4			110	
18	300	20.8	25.1		14.8			124.2	
19	300	21.3	26.2		16.2			139.6	
20	300	21.8	27.4		17.7			156.1	156.1
Total production									201
Annual increment (m^3/year)									**10.1**

Site class 4

Age	N	H dom	D before	D after	G before	G after	% thinning	Volume	Volume thinning
1	1111	1.7	1.8		0			0	
2	1111	3.5	3.6		1.1			1.4	
3	1111	5.2	5.4		2.5			4.6	
4	1111	6.9	7.1		4.4			11	
5	1111	9.1	9.4		7.7			24.9	
6	750	10.4	10.7	11.6	10	7.9	20.7	37.1	5.1
7	750	11.2	11.7		8			32	
8	750	12	12.6		9.4			40.1	
9	750	12.8	13.6		10.8			49.4	
10	750	13.6	14.5		12.4			60.2	
11	750	14.2	15		13.3			67.5	
12	750	14.8	15.6		14.3			75.4	
13	450	15.4	16.1	17.8	15.3	11.2	26.7	96	24
14	450	15.9	17.6		10.9			70.6	
15	450	16.4	19		12.8			85.4	
16	450	16.9	19.5		13.4			92.5	
17	450	17.3	20		14.1			99.9	
18	450	17.8	20.5		14.9			107.8	
19	450	18.2	21		15.6			116	
20	450	18.7	21.5		16.3			124.7	124.7
Total production									**153.8**
Annual increment (m^3/year)									**7.7**

Reference

Dupuy, B., 1990, *Etudes sur la croissance et la productivité du teck (Tectona grandis) en Côte d'Ivoire – Tables de production.* Centre Technique Forestier Tropical, Abijan, Cote d'Ivoire

Annex 5. Key facts and management history of tree stands

Table 1. *Key facts of tree stands in Asubima and Sfrensu Brohuma forest reserves.*

Tree species	Function	Plant year	Area (ha)*	Planted trees/ha	Provenance	Expected yield class
Teak	Pilot plantation (PP)	2001	53	1111	Bouaké (Cote d'Ivoire)	2
Teak	Plantation	2008	142	1667	Seed: compt 6, stumps: Sunyani, Nkoranza	2
Teak	Plantation	2009	505	1111	Seed: PP, Sunyani, Jasikan	1-2
Teak	Plantation	2010	642	1111	Seed: PP, Sunyani, Jasikan, Jimeva	1-2
Teak	Plantation	2011	869	1111	Bouaké (Seed PP)	1-2
Teak	Plantation	2012	557	1111	Bouaké (Seed PP)	1-2
Teak	Plantation planted by Ahmed Suleimani	2003-2012	91	1111	Bouaké (Seed PP)	1-2
Mixed indigenous	Plantation & buffer zone Asubima	2008-2010	235	1111	Local	3
Mixed indigenous	Plantation & buffer zone Afrensu Brohuma	2011-2012	266	1111	Local	3

**) Estimations; for exact figures see Addendum 1st May 2017, inserted at the beginning of this document.*

Table 2. *Management history of tree stands in Asubima and Afrensu Brohuma forest reserves.*

Tree stand	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Teak 2001	Pl	Pr								Th (600)		Th (450)			Th (250)						CF
Teak 2006						Pl	Bu				Pr		Pr	Th (450)				Th (250)			
Teak 2008								Pl			Pr	Pr	Th (850)		Pr			Th (450)		Pr	
Teak 2009									Pl	Bu		Pr		Th (850)	Pr		Pr	Pr	Th (400)	Pr	
Teak 2010										Pl	Bu	Bu	Pr		Pr	Th (650)	Pr	Pr	Th (400)		
Teak 2011											Pl	Bu	Bu	Pr			Th (550)	Pr	Pr		
Teak 2012												Pl	Bu		Pr		Th (550)	Pr	Pr		
Indigenous ASU																					
Indigenous AFR																					

Pl	Planting	Pr	Pruning
Bu	Beating up	Th (550)	Thinning (trees/ha)
CF	Clear fell		