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## Forest Management plan

Asubima and Afrensuh Brohuma Forest Reserves  
Ashanti Region, Ghana

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## **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 2017

## ADDENDUM

This addendum is made to clarify the surfaces under management in the area of the Akumadan plantation of Form Ghana in Ghana. In the past, different methodologies used by different institutions caused different results (surfaces) and confusion. The data below are based on GIS mapping carried out in April 2017 by Form Ghana and will be used in all documentation as from publication date.

<b>FOREST RESERVE</b>	<b>YEAR of planting (ha)</b>	<b>TOTAL AREA (ha)</b>	<b>Planted with INDIGENOUS (ha)</b>	<b>Planted with TEAK (ha)</b>	<b>UNPRODUCTIVE* (ha)</b>	<b>AREA PER RESERVE (ha)</b>
ASUBIMA	2001	66,09	11,56	53,76	0,77	1667,48
	2006	107,48	15,05	91,41	1,03	
	2008	171,52	22,35	148,16	1,01	
	2009	609,03	92,27	512,57	4,18	
	2010	713,36	88,46	612,51	12,40	
AFRENSU BROHUMA	2011	986,37	132,75	844,32	9,30	1779,86
	2012	793,49	127,80	663,12	2,56	
<b>TOTAL AKUMADAN</b>		<b>3447,34</b>	<b>490,24</b>	<b>2925,84</b>	<b>31,25</b>	<b>3447,34</b>

\*) 'Unproductive' is not reforested (because of presence of rocks or shallow soils, streams or roads).

The addendum applies to the Management Plan Akumadan and all plans and reports.

Publication date: 1<sup>st</sup> of May, 2017

M. Willem Fourie  
Managing Director Form Ghana

# 1 Introduction

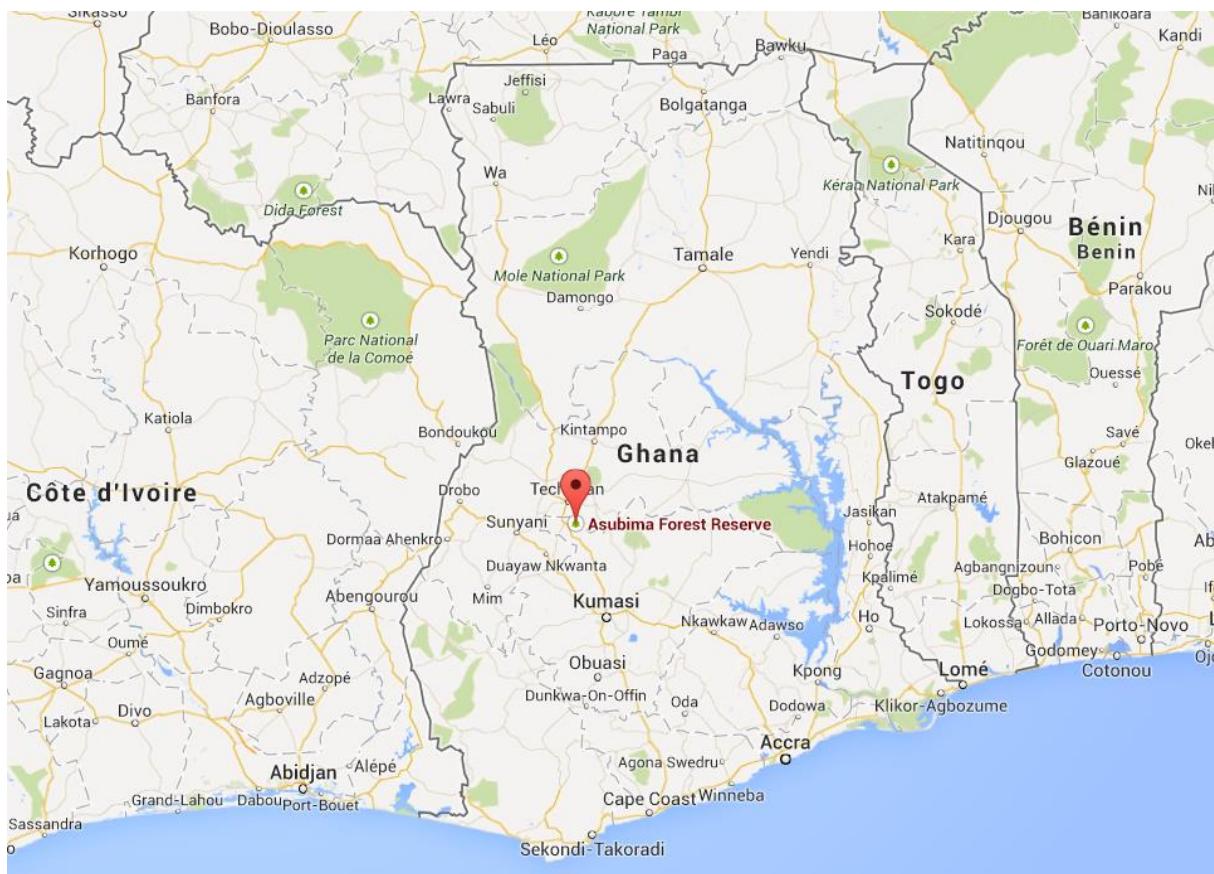
This document is the Management Plan of Form Ghana. It describes the policy and long term planning for the management of the company, and indicates what has been achieved so far. The management plan is complemented by management protocols and the block register.

References are made to several reports and literature, as well as to the company protocols. Reports include Social and Environmental Impact Assessments (SEIA), High Conservation Value analyses (HCV) and soil appraisals. Protocols describe the detailed work procedures of the company.

The management plan is updated at least every five years to incorporate new information from the field such as monitoring data, changing environment, new legislation or stakeholder meetings. An annual evaluation of the management plan takes place in the dry season (January-March). Monitoring data are used to actualise the management plan.

## 1.1 Company information

Form Ghana Ltd. is a forest plantation management company, based in central Ghana (Figure 1). The company was established by Paul Hol in 2007, as a daughter company of Dutch forestry consultancy Form international, in close cooperation with Wienco Ghana Ltd. The core business of Form Ghana is the establishment and management of sustainable forest plantations in degraded forest reserves. These areas used to be productive semi-deciduous forest ecosystems until overexploitation, bush fires and conversion to agricultural land caused severe degradation of the land over the past decades.



**Figure 1.** Map of Ghana with the location of the plantations

Form Ghana operates according to their own 'sustainability concept', a unique tool for responsible forest management, designed to balance ecological, social and economic

sustainability. The company is FSC™ certified since 2010. The Forest Stewardship Council awards their Sustainable Forest Management certificate to ‘forest managers or owners whose management practices meet the requirements of the FSC Principles and Criteria’ (<https://ic.fsc.org>).

The company’s reforestation activities have also been independently validated under the Verified Carbon Standard (VCS). ‘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<sub>2</sub>e), which can be generated by reducing or removing greenhouse gases.’ ([www.v-c-s.org](http://www.v-c-s.org))

Form international is a Dutch consultancy company that provides technical assistance to the management Form Ghana.

## 1.2 Document structure

This Management Plan describes the management system of Form Ghana Ltd., based on the FSC Principles and Criteria, includes the following topics:

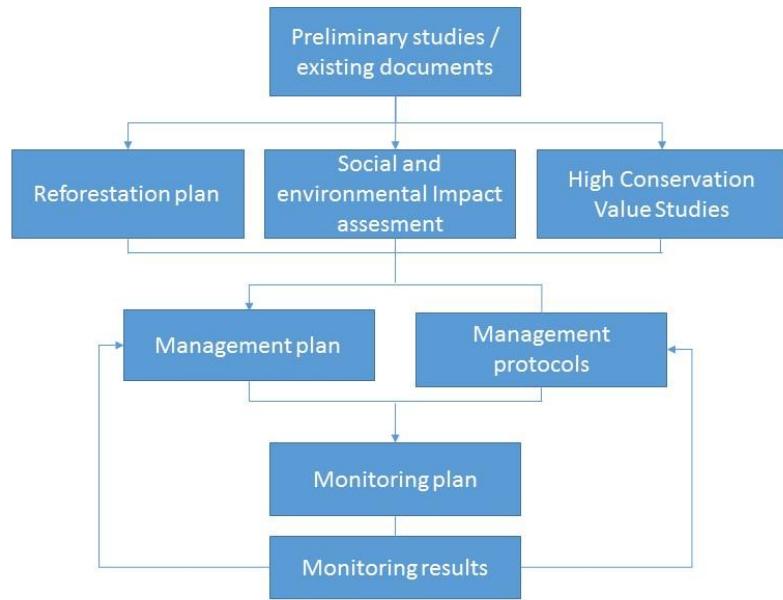
- An overview of the physical environment (climate, water and soil condition, biodiversity, etc.) and social-economic environment (village facilities, occupation, level of education, housing and transportation etc.) of Asubima and Afrens Brohuma FR.
- The forest management objectives, elaborating on 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:

- The Reforestation Plan of Asubima and Afrens Brohuma Forest Reserves
- The Social and Environmental Impact Assessment (SEIA) reports for Asubima and Afrens Brohuma Forest Reserves
- The High Conservation Value Forest analyses of Asubima and Afrens Brohuma Forest Reserves

Complementary to the Management Plan, Form Ghana uses a system of separate protocols that describe the processes of environmental and social management. A list of the protocols is included in Annex 1 of this Management Plan.

The effectiveness of management is checked annually through monitoring activities. The Management Plan 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 or management plans. The relations between the various documents is described in the schedule below.

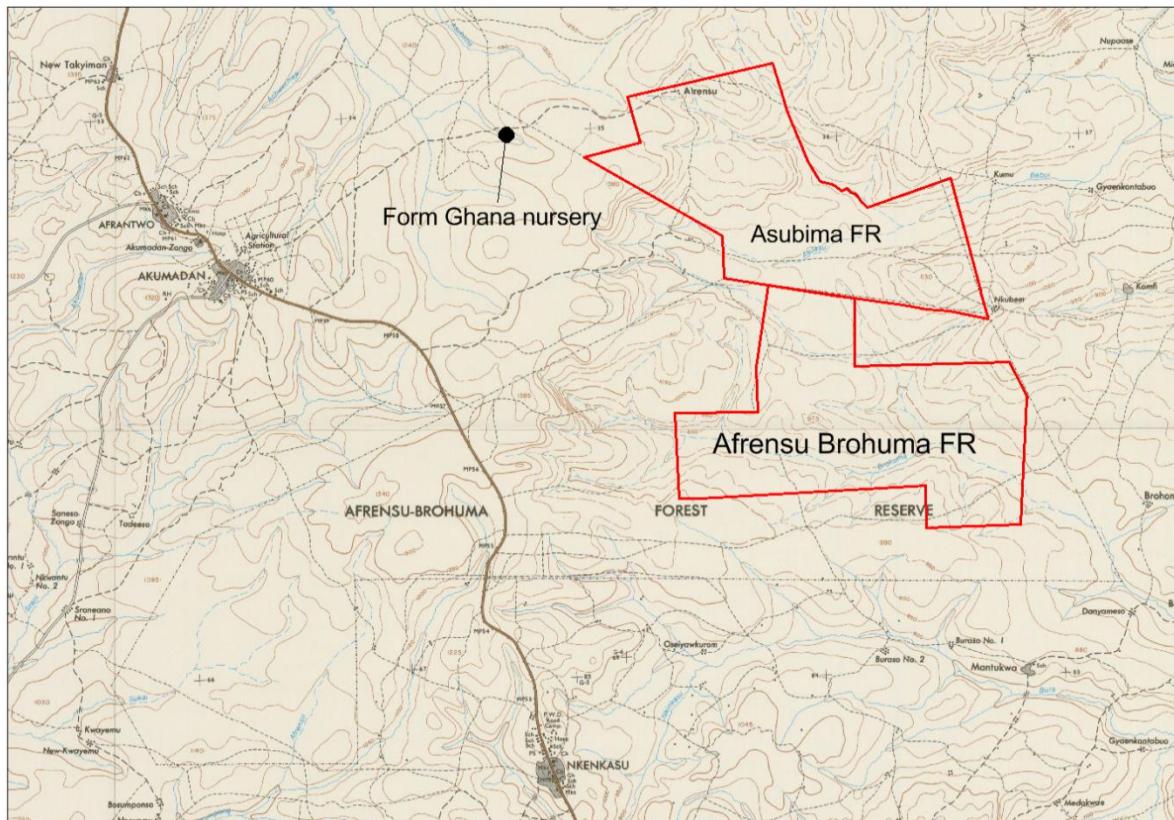


**Figure 37. Links between various documents**

The environmental and social management of Form Ghana incorporates the recommendations and mitigation measures proposed in the impact assessments of Asubima and Afrenso Brohuma Forest Reserves.

## 2 Site description

Form Ghana operates in two degraded forest reserves in Ghana's Ashanti Region: Asubima and Afrens 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 Afrens Brohuma FR share a common boundary over 4,800m of which 1,600m is part of the Form Ghana concessions.



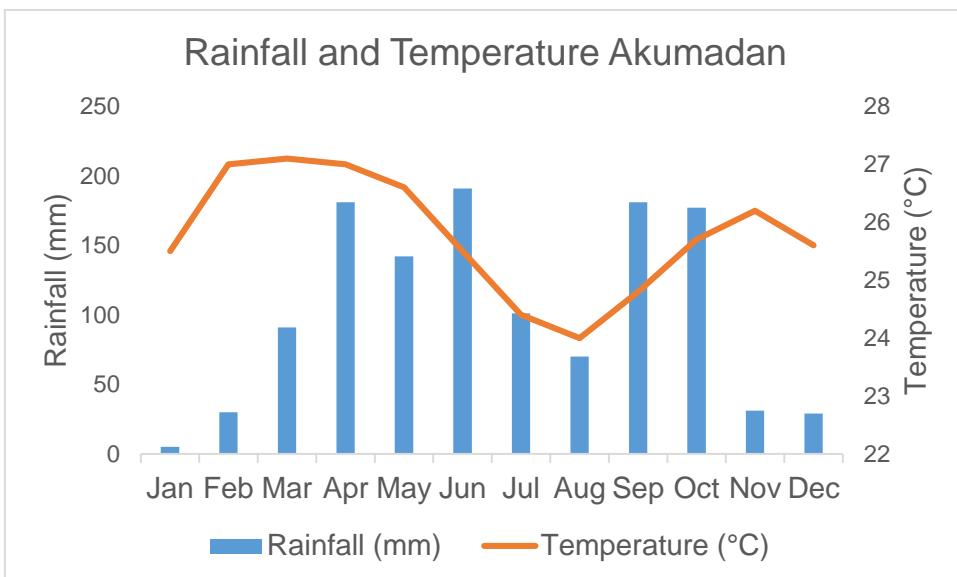
**Figure 2.** Outlines of the plantation and the position of the nursery

### 2.1 Climate

Asubima and Afrens 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 Afrens Brohuma FR fall well within this range.



**Figure 3.** 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 Afrens 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 Afrens 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 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 Social and Environmental Impact Assessment (SEIA), a flora and fauna inventory was conducted in the riparian zones of Asubima and Afrensuh Brohuma Forest Reserves. The results of the flora inventory show a vegetation cover typical for highly degraded areas, with many light-demanding grass and herb species. For the fauna inventory, birds, mammals, birds, reptiles and butterflies were recorded. Most species of birds and small mammals were common in the area and typical for savannah vegetation. Some rare species of snakes and mammals were recorded, and even a dwarf crocodile, a CITES red-list species, was sighted in Afrensuh Brohuma Forest Reserve. The detailed inventories can be found in the SEIA reports.

A number of scarlet star-rated species was found in both forest reserves (table 2.1). Most of these species are also planted by Form Ghana (see table 5.1 in chapter 5.3 of this document).

**Table 2.1. Scarlet star-rated species found in Asubima and Afrensuh Brohuma FR.**

Local Name/Common name	Scientific name	Akumadan	Berekum
Awiemfosamina	<i>Albizia ferruginea</i>	x	x
Edinam	<i>Entandrophragma angolense</i>	x	
Sapele/Efoborodidwo	<i>Entandrophragma cylindricum</i>	x	
Utile	<i>Entandrophragma utile</i>	x	
Krumben	<i>Khaya anthotheca</i>	x	x
Dubini	<i>Khaya ivorensis</i>	x	
Odum	<i>Milicia excelsa</i>	x	x
Kusia	<i>Nauclea diderrichii</i>	x	
Kokrodua	<i>Pericopsis elata</i>	x	
Wawa	<i>Triplochiton scleroxylon</i>	x	x

## 2.4 Socio-economic environment

Extensive social assessments have been done in Asubima and Afrensuh 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 Afrensuh Brohuma FR:

No major negative impacts of the proposed project were identified in Afrensuh 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 Legal registration

The official establishment of Form Ghana in Ghana is documented by a registration certificate (CA-387,338/2421), a certificate of incorporation (CA-37,338) and a certificate to commence business (CA-37,338 TIN 824VO25997). Form Ghana operates according to the applicable national legislation and international conventions, described in Protocol 1.

#### 3.2 Plantation infrastructure

One feeder road connects Form Ghana's plantations in Asubima and Afrens 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.

#### 3.3 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 Afrens 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 quadrants 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.

#### 3.4 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. The Akumadan site is managed by the Operations Manager. He directs a team consisting of a plantation manager, a nursery supervisor, a monitoring manager, a head of security, stores manager, a nurse and a workshop manager. These in turn direct teams or team leaders who are each responsible for a team. The organogram of the organisation can be found in Annex 3.

## 4 Sustainability concept

Both Asubima and Afrensuh 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 forest environment were lost in the process.

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 nowadays 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. International investors were attracted for reforestation and restoration of the reserves. Form Ghana operates within this framework in Asubima and Afrensuh Brohuma forest reserves.

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 global demand for sustainable roundwood. Since the remaining natural forests in Ghana are in a deplorable state, plantation forests are likely to become even more important 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 first commercial thinning has recently taken place in a 60ha pilot plantation, planted in 2001 in Asubima Forest Reserve. Sales from the pilot plantation will give an indication of the value of the younger parts of the plantation. The uneven age character of the plantation due to annual planting will assure periodical revenues from sales of billets and poles.

### 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 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 microfauna 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 reduced to 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. 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 Afrens 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](https://en.wikipedia.org)). It was concluded that both forest reserves are highly degraded and cannot be classified as high conservation value forests. The full analyses are presented in the HCVF reports 2019 for both forest reserves.

#### **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 Afrens 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 Afrens 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 ([www.formghana.com](http://www.formghana.com)).

## 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. 60ha in 2001 in Asubima Forest Reserve. Planting continued in Asubima and Afrens Brohuma FR in the period 2008 – 2012. A total area of 3416 ha has been planted in both forest reserves (2925,84 teak and 490,24 ha of indigenous). The total area of the both reserves also contains some unproductive parts, and all together covers 3447,34 ha.

In Asubima FR, 87% of the planted area was planted with teak and 13% with indigenous tree species, or left for natural regeneration. In Afrens Brohuma, 83% was teak and 17% 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

Valley bottoms and rocky hilltops were found to be unsuitable for teak. On areas that were classified as unsuitable for teak, 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.

### 5.1 Teak: justification of plantation species

Teak (*Tectona grandis*) is the principle 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 Loupe, 2000; Dupuy and Verhaegen, 1993; Keogh and Pentsil, 2001; Behaghel, 1999). The price of Teak is about €300/m<sup>3</sup> for saw logs. For plantation saw logs of Wawa (*Triplochiton scleroxylon*) or Ofram (*Terminalia superba*), this price is ca. €50/m<sup>3</sup>. With an unrivalled growth rate of 15 m<sup>3</sup>/yr/ha, teak is currently the only commercially viable option.

Teak silviculture has been practiced since the 19<sup>th</sup> 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 was planted in mixed stands in areas where the soil conditions were not favourable for teak 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	<i>Albizia ferruginea</i>
Bombax	<i>Rhodognaphalon brevicuspe</i>
Bonsamdua	<i>Distemonantus benthamianus</i>
Emeri*	<i>Terminalia ivorensis</i>
Kokrodua	<i>Pericopsis elata</i>
Kusia	<i>Nauclea diderrichii</i>
Mahogany	<i>Khaya anthotheca</i>
Mansonia	<i>Mansonia altissima</i>
Ofram*	<i>Terminalia superba</i>
Onyina	<i>Ceiba pentandra</i>
Potrodom	<i>Erythrophleum ivorensis</i>
Watapuo	<i>Cola gigantea</i>
Wawa*	<i>Triplochiton scleroxylon</i>

\* Fast growing species

All trees with >20cm DBH are protected.

## 5.4 Buffer zones

Form Ghana strives to conserve vegetation strips of 30m on each side of rivers and streams. These “buffer zones” will develop into 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 takes place in the buffer zones.

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 *Pennisetum 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 Afrensuh Brohuma Forest Reserves: plant communities have changed dramatically from dense forest vegetation to savannah grasslands, wildlife declined in numbers and savannah bird 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 are now 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 foresee many positive effects of Form Ghana's reforestation activities on biodiversity, soils, hydrology, local climate and carbon balance. Form Ghana intends to manage their forest plantation in such a way that these positive impacts are optimised and negative impacts are avoided or mitigated.

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 given priority with the employment of skilled and unskilled workers. 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.

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 phytosanitary agents and the distance between the crops and the planted trees. The project management will maintain its full right to remove any intercropping farmers from the plantation if they do not respect the agreement.

### **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, 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 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 spots 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<sup>1</sup> ( $H_{dom}$ ) 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 <sup>3</sup> after 20 years)	Mean annual increment (m <sup>3</sup> /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 Afrens 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 12 yrs (thinning) m <sup>3</sup>	Yield 20 yrs (clearcut) m <sup>3</sup>	Total yield
2001	53	2,183	10,975	13,158
2008	100	4,118	20,707	24,825
2009	500	20,594	103,538	124,132
2010	1,000	39,514	207,076	246,590
2011	1,000	39,514	207,076	246,590
2012	1,000	39,514	207,076	246,590
<b>Total</b>	<b>3,653</b>	<b>145,437</b>	<b>756,448</b>	<b>901,885</b>

<sup>1</sup> 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<sup>3</sup>/ha, final harvested volume is 207m<sup>3</sup>/ha, total 247 m<sup>3</sup>/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.

## 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 4.** 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, improve 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

### 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 Prevention of illegal activities**

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 04 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 16 Storage of fuel, lubricants and toxins**

This document prescribes how hazardous substances must be handled and stored.

- **P 18 Machine maintenance**

This document prescribes maintenance of machines to assure their continued functioning.

### Stakeholder engagement

- **P 06 Information policy personnel and local population**

This document describes how personnel and the local population are informed on Form Ghana activities, and how stakeholders can engage with Form Ghana

- **P 07 Conflict management**

This documents describes how grievances are dealt with and how grievances are redressed.

- **Stakeholder engagement plan**

This plan identifies the stakeholders of Form Ghana and describes how stakeholders are engaged.

- **Resettlement Action Plan**

This document describes the resettlement activities that Form Ghana undertakes for people that need as a consequence of Form Ghana activities.

- **Community Development Plan**

This plan describes the community development activities that Form Ghana undertakes

### Health and safety management

- **P 08 First Aid Procedures & Emergency Evacuation**

This document prescribes how to deal in cases of emergency.

- **P 09 Transport of personnel**

This documents prescribes how personnel can be transported.

- **P 10 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 procedures**

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 14 Technical performance in the nursery**

This document describes all the activities in the nursery 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 21 Fire prevention and fire-fighting**

This document describes how fires will be prevented and when needed combatted.

- **P 24 Road construction and maintenance**

This document prescribes how roads are to be constructed and maintained.

- **P 25 Log extraction**

This document describes the system for extracting and preparing logs during forest harvesting.

## Monitoring

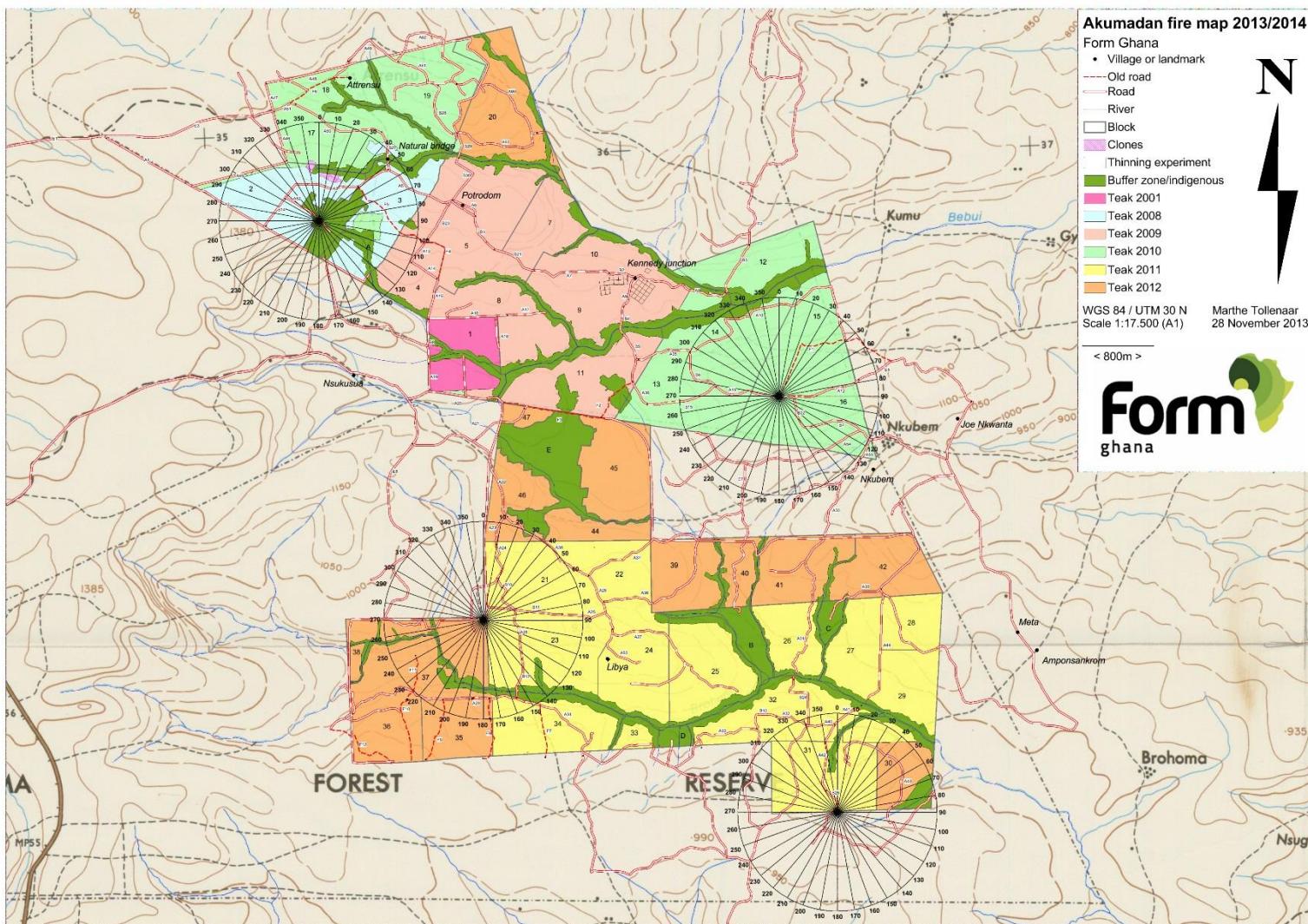
- **P 13 Monitoring**

This protocol describes the various monitoring activities

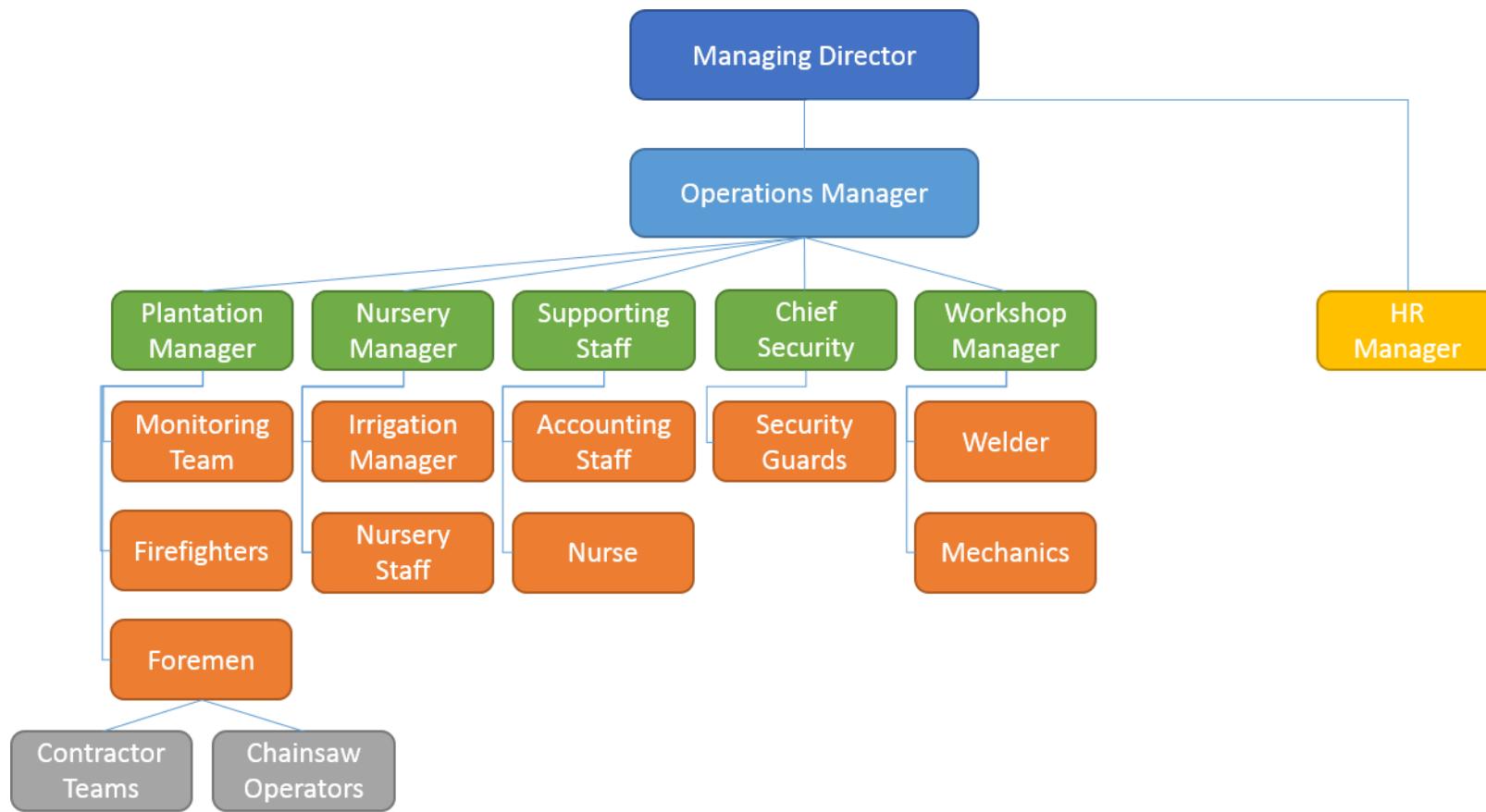
- **Monitoring plan**

This document describes the planning of the various monitoring activities

## Annex 2. FG plantations in Asubima and Afrensu Brohuma



### Annex 3. Organisational structure of Form Ghana



#### 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
<b>Total production</b>								<b>350.3</b>	
<b>Annual increment (m<sup>3</sup>/year)</b>								<b>17.5</b>	

**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
<b>Total production</b>								<b>283.9</b>	
<b>Annual increment (m<sup>3</sup>/year)</b>								<b>14.2</b>	

**Site class 3**

<b>Age</b>	<b>N</b>	<b>H dom</b>	<b>D before</b>	<b>D after</b>	<b>G before</b>	<b>G after</b>	<b>% thinning</b>	<b>Volume</b>	<b>Volume thinning</b>
<b>1</b>	1111	2.2	2.2		0			0	
<b>2</b>	1111	4.4	4.4		1.7			2.7	
<b>3</b>	1111	6.6	6.6		3.8			9.1	
<b>4</b>	1111	8.8	8.8		6.8			21.6	
<b>5</b>	750	11	11	12.1	10.6	8.6	18.3	42.2	4.2
<b>6</b>	750	12	12.2		8.8			38.3	
<b>7</b>	750	13	13.4		10.6			50	
<b>8</b>	750	14	14.6		12.6			63.9	
<b>9</b>	750	15	15.8		14.7			80.2	
<b>10</b>	450	15.8	16.6	18.3	16.2	11.8	27.1	103.4	13.4
<b>11</b>	450	16.5	17.7		11			73.3	
<b>12</b>	450	17.1	18.8		12.4			85.9	
<b>13</b>	450	17.8	19.8		13.9			99.7	
<b>14</b>	450	18.4	20.9		15.5			115	
<b>15</b>	450	19.1	22		17.1			131.7	
<b>16</b>	300	19.7	22.7	24.7	18.2	14.4	21.1	145.3	27.3
<b>17</b>	300	20.2	23.9		13.4			110	
<b>18</b>	300	20.8	25.1		14.8			124.2	
<b>19</b>	300	21.3	26.2		16.2			139.6	
<b>20</b>	300	21.8	27.4		17.7			156.1	156.1
<b>Total production</b>								201	
<b>Annual increment (m<sup>3</sup>/year)</b>								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
<b>Total production</b>								<b>153.8</b>	
<b>Annual increment (m<sup>3</sup>/year)</b>								<b>7.7</b>	

**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, Côte d'Ivoire

## Annex 5. Key facts and management history of tree stands

**Table 1.** Key facts of tree stands in Asubima and Sfrensou 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 1<sup>st</sup> May 2017, inserted at the beginning of this document.

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

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

Pl Planting  
 Bu Beating up

Pr Pruning  
 Th (600) Thinning (trees/ha)