
Monitoring report 2014

Asubima & Afrensu Brohuma Forest Reserves



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1. INTRODUCTION

Management is a continuous process. This means that the management will be adapted over time related to changes in the field. To keep track of these changes, Form Ghana applies a system of monitoring in which annually information is gathered. The process of evaluation and adaptation will lead to further fine-tuning of the management plan.

The current report informs on the various monitoring activities that have taken place the past year, and what has been learned from it. As more knowledge is gained on monitoring activities, these are further refined and the setup of the monitoring system will be adapted.

This annual monitoring report is public to allow interested persons to be informed on the progress of Form Ghana and the impact its activities have on the people and the environment in Asubima and Afrensu Brohuma Forest Reserves.

Form Ghana Ltd.

Willem Fourie

General Manager

1.1 Plantation monitoring

The objective of Form Ghana is to establish and manage the timber plantation in an ecologically, financially and socially sustainable manner. These management objectives are divided into criteria and for each criterion, a set of measurable indicators are determined as well as the means to verify them (Table 1).

Table 1. Monitoring framework

Management objectives	Criterion	Indicator	Verifier
1. Establish and manage the timber plantation in an ecologically sustainable manner with a maximum of 90% Teak and at least 10% of mixed local species with conservation of natural, riparian forest	1.1 Extent and condition of forest	1.1.1 Area planted with Teak	Map
		1.1.2 Area managed as forest plantation / buffer zone	Map
		1.1.3 Changes in planted area	Map
	1.2 Biological diversity	1.2.1 Extent of area protected	Map
		1.2.2 Fauna population and diversity in the forest reserves	Report
		1.2.3. Flora diversity in the buffer zones	PSP
		1.2.3. Existence and implementation of procedures to identify / protect endangered, rare and threatened species	Procedures
	1.3 Forest health	1.3.1 Check of the growth rate of the plantation	PSP
		1.3.2 Check of the growth rate of the Buffer zones	PSP
		1.3.3 Monitoring of fire frequency	Fire report
	1.4 Soil protection	1.4.1 Procedures to protect soil productivity and avoid erosion	Procedures
		1.4.2 Effectiveness of activities undertaken to avoid soil erosion	PSP
		1.4.3 Procedures to avoid impact from work in the forest	Procedures
	1.5 Water protection	1.5.1 Procedures to protect forest and vegetation along water courses	Procedures
		1.5.2 Checking of water quality	Sample analysis
2. Guarantee financial and economic sustainability through the generation of income from the produced round-wood and carbon sequestration	2.1 Forest production	2.1.1 Harvest of round wood	Tables
		2.1.2 Comparison of yield with yield tables	Tables
		2.1.3 Calculation of current stored carbon in the plantation	Calculation
		2.1.4 Calculation of current stored carbon in the buffer zones	Calculation
	2.2. economic aspects	2.2.1. Cost benefit of plantation	Table
		2.2.2 Value of wood sales	Sales data
3. Provide social benefits by offering good economic conditions for	3.1 Social benefits	3.1.1 Number of people (partially) depending on the plantation for their livelihood (employees, inter croppers, out growers)	Annual report

employees and the surrounding smallholder community	3.1.2 Training and capacity building for employees, inter croppers and out growers	Table
	3.1.3 Information of the public	Website, stakeholder meetings
	3.1.4 Worker health / Accidents on work floor	Statistics

1.2 Monitoring methods

In order to check compliance with the management objectives, Form Ghana has developed a monitoring system consisting of several activities. Different monitoring methods are adopted to optimize verification of different indicators. All indicators are monitored at least once every five years. Specific indicators can be monitored annually or bi-annually.

Each indicator is described in detail in the following paragraphs.

1.2.1 Extent and forest condition

By the end of 2012, a total of 3,469 ha of land in Asubima and Afrensu Brohuma Forest Reserves falls under the management of Form Ghana. See Appendix 1 for the development of the plantation over time.

1.2.2 Biological diversity

Currently, 14% of the area consists of indigenous vegetation and is actively being restored into its former state as productive forests (Table 2).

Table 2. Stratification of Form Ghana plantations

Planting year	Area (ha)	Portion	Species
2001	53	2%	Teak
2008	142	4%	Teak
2009	505	15%	Teak
2010	643	19%	Teak
2011	869	25%	Teak
2012	764	22%	Teak
<i>Subtotal teak</i>	2976	86%	Teak
2008 - 2012	493	14%	Indigenous trees and buffer zones
Total	3469	100%	

No monitoring has been performed on the buffer zone flora nor on the fauna. These are subject to monitoring every 5 years. This is due for flora in 2015 and for fauna in 2016.

In the plantation one individual of the CITES species *Kokrodua* (*Percicopsis elata*) is present. This tree was discovered in 2010, and verification has confirmed it is still in good health.

1.2.3 Forest health

Analyses of forest growth and health as well as soil erosion are based on the PSP measurements taken in the plantation. Every year after planting, additional plots are created in the newly planted compartments. The number of plots will therefore increase yearly.

The basic shape of a PSP is a circular plot with a pole in the centre. GPS coordinates of the pole determine the site location. Each sample plot has a size of 800m². This plot size does not change over time and is the size is chosen so that a plot contains a sufficient amount of trees even after subsequent thinnings.

Height and dbh (diameter at breast height) of the trees in the plots as well as overall health of the plantation is assessed annually.

The measurements taken in these plots are:

- Date of measurement
- Tree diameter at breast height (dbh): the diameter of each tree is measured at breast height with measurement tape or calliper.
- Height: The height of all trees is measured as accurately as possible with a clinometer (Suunto) or a measurement pole;
- Tree health, pests and diseases: it is recorded whether the measured trees are healthy or affected by disease.
- Soil erosion: any visual sign of erosion will be noted (rills, gullies, splash erosion, crusting);
- Undergrowth: A note is written on the amount of undergrowth and the type of undergrowth.

The data from these plots are entered in an Excel sheet, where they are further analysed. A summary of the plots for this monitoring activity is presented below in table 3.

The teak strata 2001, 2009, 2011 and indigenous 2011 were monitored this year with PSPs. A total of 196 PSPs have been selected this year for monitoring plantation growth and performance.

The 184 teak plots that were monitored this year, with a total sampling area of 14.7 ha, represent 1,428 hectare of plantation, meaning that the sampling covers 1% of the plantation.

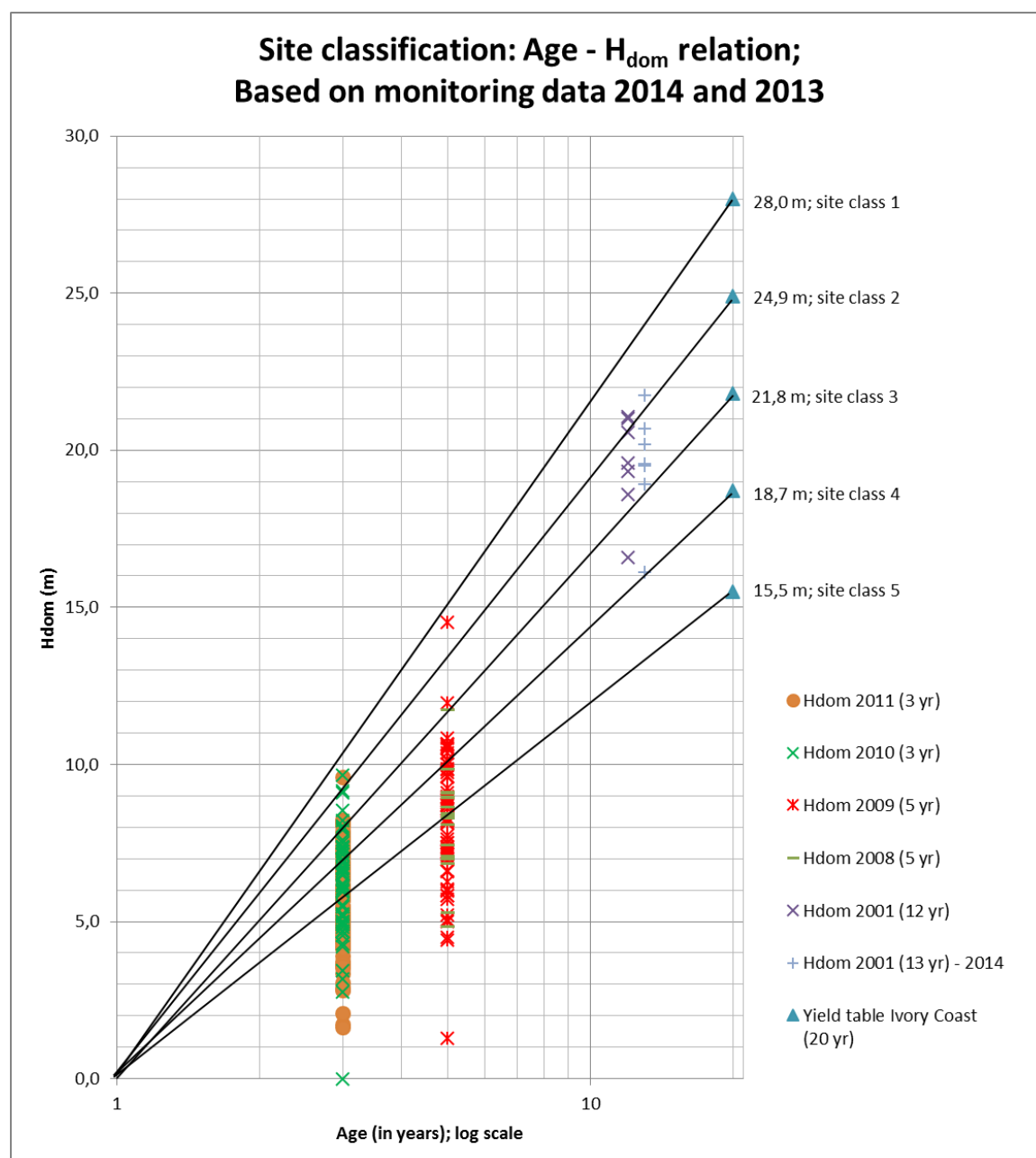
The 9 indigenous-2011 PSP, with a total sampling area of 0.72 ha, represent 24.3 hectare of indigenous planting, covering 3 % of the area.

Table 3. Plantation area and PSPs per forest type and plant year. Only **highlighted** strata were measured in 2013 with PSPs.

Forest type	Plant year	Plantation Area (ha)	PSP Area (ha)	# PSPs	Sampling density
Teak plantation	2001	53.4	0.56	7	1.0%
	2008	141.9	1.44	18	1.0%
	2009	505.4	5.28	66	1.0%
	2010	642.7	6.80	85	1.1%
	2011	869.2	8.88	111	1.0%
	2012	647.8	no PSP*		
	Achmed Teak 2012	116.0	0.96	12	0.8%
<i>Total Teak</i>	<i>Subtotal</i>	2976.4	23.92	299	1.0%
Indigenous plantation	2008-2010	43.1	0.72	9	1.7%
	2011	24.3	0.72	9	3.0%
	2012	78.3			
Buffer zone	2001-2010	183.8	*		
	2011-2012	163.4	*		
<i>Total Indigenous vegetation</i>	<i>Subtotal</i>	492.9	1.44	18	
Total		3469.3	24.80	317	

*) In the teak2012 are, no PSP's have been measured yet. Therefore, to calculate the overall sampling density in teak plantations, the teak2012 area has not been taken into account.

In the graph below the dominant height is compared to the height development from the yield table. This allows a comparison of growth speed. It must be noted that the height growth as presented in the yield table is a dominant height (100 highest trees per hectare).



The contents of table four are discussed in the sections below.

Table 4. Basic growth statistics

Plant year	N # /ha	+-	H_{lav} (m)	+-	H_{dom} (m)	+-	Dbh (cm)	+-	V (m^3/ha)	+-	G (m^2/ha)	+-
2001	446	113	16.1	2.7	19.5	1.7	19.3	3.6	99.9	20.7	14.8	2.5
2001 (after corr.)*	375	75	18.2	1.6	19.5	1.7	22.0	1.7	99.9	20.7	14.8	2.5
2009	722	222	6.5	2.0	8.2	2.1	7.4	2.4	12.0	10.0	3.9	2.7
2011	676	252	4.2	1.5	5.6	1.6	4.3	1.5	2.9	3.2	1.3	1.2

N is calculated as the total number of trees/records per plot ($800m^2$), then extrapolated to one hectare (N/ha) and the average of all plots of the same plantyear is calculated.

H_{av} = the average height per plot, then the average of all plots of the same plantyear is calculated.

H_{dom} = the average height of the 100 largest (Dbh) trees per ha. The average height of the 8 largest trees per plot is calculated, resulting in the H_{dom} per plot. Then the average of all plots of the same plantyear is calculated.

Dbh = Diameter at breast height (1.3 m.). The average per plot is calculated, then the average of all plots of the same plantyear is calculated.

V is calculated as $V_{tree} = \pi * r^2 * H * \text{form factor}$. (r = radius = $\frac{1}{2}$ Dbh). Then the sum of the volume per plot is calculated, extrapolated to a Volume / ha, then the average of all plots of the same plantyear.

Form factors are based on the adapted Ivory Coast yield tables (0.36)

Stocking

The average stocking of the 2001 plantation is 375 trees / ha. Last year this was 395 trees / ha. This variation can be attributed partially to variations in measurements and to natural mortality. The stocking of the 2009 plantation is 722 trees/ha. In 2012 the stocking was 911. In this part a thinning has been completed. In the 2011 area average stocking is 676 trees / ha. This stocking was 857. No thinnings were performed here, so this decrease has to be attributed to natural mortality which is too high.

With the data available for plant years 2001 and 2008-2011 it is possible to calculate height growth projections over time for the teak stands. The mean Akumadan height growth curve can be compared with the curves of the yield tables. The mean growth curve for Akumadan is currently between yield classes 3 and 4.

Height

The 2001 plantation the dominant height is 19,5 m. The corrected figure (different method) for 2013 was also 19,5. This is a sign that height measurements are difficult to do accurately. The current dominant height corresponds with a yield class between 2 and 3 of the Ivory Coast Yield tables.

Stands of plant year 2009 have a dominant height of 8,2 m and an average height of 6,5 m. In 2012 the dominant height of the 200 area was 6,9. From this we can conclude that the dominant height growth is about 0,65 m. per year. We have to note however that dominant height was determined in a different manner this year (see effects on 2001 in table 3).

Stands of the year 2011 have a dominant height of 5,6 , in 2012 the dominant height was 2,1m. The height has increased with 1,75 m. per year.

DBH

The diameter of 2001 has increased from 19,9 in 2013 to 22,0 in 2014. This means a diameter growth of 2,1 cm. per year.

The 2009 area has grown from 4,2 cm. in 2012 to 7,4 in 2014. The annual diameter growth was 1,6 cm.

The 2011 area has grown from 0,2 cm. in 2012 to 4,3 cm. in 2014. The annual diameter growth was 2,05 cm.

Volume

The 2001 area has increased from 81,7 m³ per hectare in 2013 to 99,9 m³ per hectare 2014. This means a volume growth of 18,2 m³/ha/yr. which would correspond to the highest yield class in the Ivory Coast yield table.

The 2009 area has increased from 3,5 m³/ha to 12,0 m³/ha from 2012 to 2014. The volume growth per year is 4,25 m³/ha.

The 2011 area has increased from 0,04 to 2,9 m³/ha. This is a growth of 1,4 m³ per hectare.

Indigenous plantation

PSPs are laid out in indigenous plantations (excluding buffer zones). This year only the 9 plots of Indigenous-2011 were measured. This is the first time this area has been assessed, there are no earlier data on development of the indigenous-2011 plantation.

Tree stock level is between 13 and 563 trees/ha, with on average 257 trees/ha. With initial stocks of 1111 trees/ha there is an average survival rate of 23%, with minimum 1% and maximum 51%. Considering this the mortality is high.

Indigenous-2011 PLOT	# of trees in plot	N (# / ha)	Survival %	Average Height (m)	St dev	Average Dbh (cm)	St dev
285	2	25	2%	1,1	0,2		
288	3	38	3%	0,8	0,1		
290	35	438	39%	2,4	1,1	2,6	1,6
291	45	563	51%	3,5	1,8	4,6	2,9
292	33	425	37%	1,7	0,7	1,9	0,9
293	21	288	24%	3,9	1,1	3,6	1,5
294	25	313	28%	5,0	1,4	5,9	2,3
295	17	213	19%	2,6	1,4	3,5	2,0
AVERAGE	181	283	23%	3,0	1,7	3,7	2,4

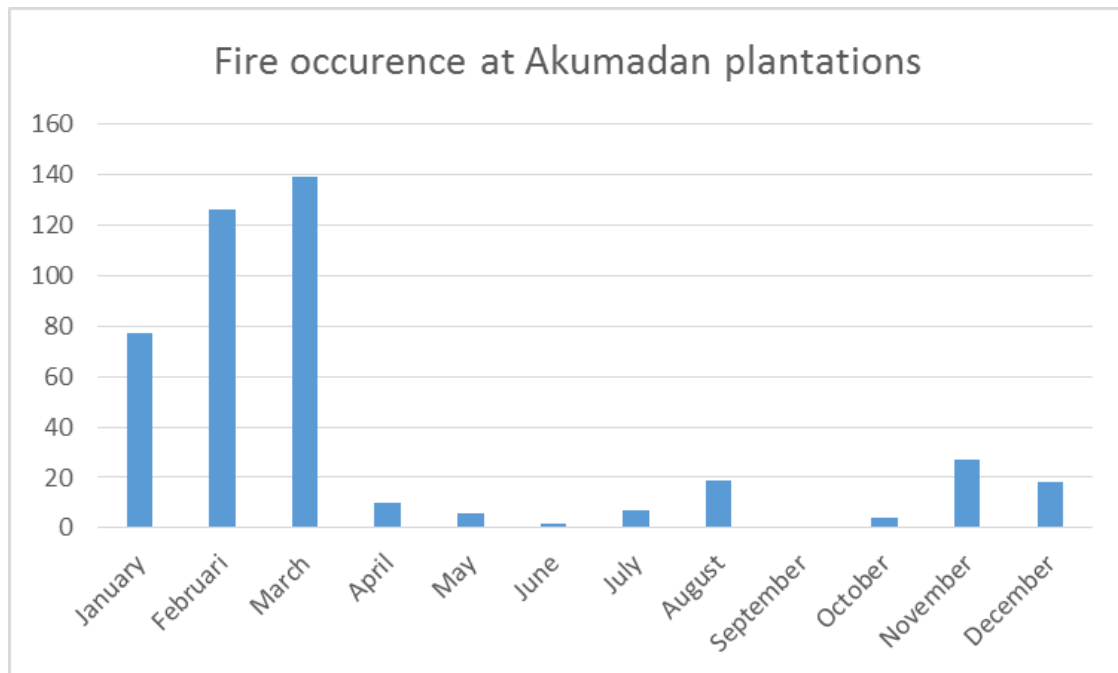
Biological diversity

The monitoring of biological diversity has started in 2008. In 2011 research on birds, small mammals, butterflies and vegetation in the buffer zones was done. The results of this study are reported in a specific report available on the Form Ghana [website](#).

It is not expected that significant change can be measured on a yearly basis and therefore monitoring of biological diversity was not done in 2013. The next measurements are expected in 2016.

Protection against fire

Fire is a great potential threat to the plantations. In 2014, 571 fires were reported by the security team. Of these 565 were located outside the Form Ghana area. 5 fires were within the Form Ghana boundaries, but could quickly be quenched by the rapid response team. 1 announced fire proved to be a mistake due to bad visibility. Fire occurs mostly during the first three months of the year and their occurrence quickly drops with the onset of rains.



1.2.4 Soil protection

On sloped terrain erosion can be a problem, especially on the more sandy soils of Asubima. For this reason we pay special attention to erosions on our roads and in the plantation. Especially in older plantations, erosion can become a problem as the dense crowns can create shade that few understory plants can survive in. By regular and timely thinning this erosion can be kept in check as it stimulates undergrowth.

In the permanent sample plots erosion is checked every time the plot is measured. No erosion was found during PSP monitoring in 2013.

1.2.5 Water protection

The protection of the buffer zones is effective in the respect that they have been fully planted. The trees planted will need time to grow into trees and in that way restoring the buffer zones in full.

Water samples in 2008 showed that all water was polluted to a certain extent with silt and pesticides. Now that all agricultural pesticides except round-up are banned and the vegetation restored this situation was expected to change.

The water quality in Asubima FR was assessed again in 2011 at strategic points where streams enter and leave the plantation. The data showed that the water in the streams

is of drinking quality (according to WHO standards) for all factors except iron, colour and turbidity. It shows that the contamination of the water is minimal.

Measurements of hydrological characteristics in streams in Afrensu Brohuma FR in 2013 show that nearly all streams are polluted quite severely. The restoration of the 30 meter buffer zones along the water courses is expected to reduce erosion and prevent chemicals from entering the water, as was observed in Asubima FR.

1.2.6 Rainfall

The precipitation in the area was this year measured at 5 points:

- In the nursery
- At fire tower # 1 in the West of the Asubima plantation
- At fire tower # 2 in the Eastern corner of the Asubima plantation.
- At fire tower # 3 in the Afrensu Brohuma plantation
- At fire tower # 4 in the Afrensu Brohuma plantation

The data shows that the rainfall fluctuates around 1100 mm, with a peak in 2010 and low levels in 2012 and 2013. The average rainfall of 1191 mm is normal for the area.

Table 5. Average rainfall in Akumadan.

Nursery Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2009	0	0	43	110	125	222	138	25	112	125	64	0	964
2010	0	54	50	184	119	162	309	63	136	258	28	27	1390
2011	8	48	65	51	128	339	67	38	257	241	0	0	1241
2012	0	33	75	106	229	128	67	8	25	253	64	13	1000
2013	0	73	97	64	189	59	123	25	249	97	27	4	1005
2014	15	26	129	181	125	197	60	94	198	145	88	0	1256
Tower 1	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2011	11	31	13	56	93	254	69	57	246	349	0	0	1178
2012	0	31	62	120	162	168	87	9	25	223	75	45	1007
2013	0	86	132	85	178	55	121	9	214	129	71	0	1080
2014	12	27	104	171	114	158	65	81	166	133	89	0	1118
Tower 2	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2011	7	22	13	91	136	207	85	118	242	216	0	0	1137
2012	0	45	97	145	187	102	111	0	85	183	84	38	1076
2013	0	119	142	90	137	49	133	16	191	94	60	0	1029
2014	25	15	110	302	84	201	74	183	152	173	131	0	1448
Tower 3	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2012	0	45	75	130	180	142	111	0	9	162	92	13	958
2013	0	72	102	101	138	59	200	5	236	95	57	0	1065
2014	26	24	62	235	110	130	72	109	112	117	101	0	1098
Tower 4	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2012	0	0	0	0	0	0	0	0	0	98	97	2	197
2013	0	35	183	197	196	92	199	21	307	82	102	0	1413

2014	24	27	114	162	66	167	26	71	171	136	73	0	1037
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1.2.7 Forest production

In 2014 the 2009 area has been thinned. About 25 to 30% of the standing stems was removed during this operation.

In 2014 no new monitoring and calculations have been performed to establish the carbon content of the plantations or in the buffer zones.

1.3 Economic aspects

No timber has been harvested in 2014.

1.4 Social benefits

Number of people (partially) dependant on the plantation

The social evaluation in the communities around the plantation. In these communities a total of 1038 people live.

Community	Number of inhabitants	Off or On Reserve	Work at Form Ghana
Yaa-Danso	150	Off	5
Atrensu	35	On	n/a
Nkubem	90	Off	5
Libya	40	On	5
Joe-Nkwanta	350	Off	70
Amponsakrom	120	Off	50
Atinga	0	On	0
Second Tower hamlet	3	On	0
Meta	250	Off	35
Total	1038		170

In total 170 people from these communities have found permanent and temporary employment at Form Ghana. The most frequent jobs are in contract weeding, followed by security and fire patrol team. Most of the people indicate they are engaged in agriculture. The people perceive the presence of Form Ghana as good for the development of the forest and the possibility to earn an income. They state income levels have gone up. Some of the people indicate that through the presence of Form Ghana they now have access to legal farming land through intercropping. People also indicate that forests are being restored and that they think the wildlife population is slowly increasing. The quality of the water in the streams is perceived as good.

Information to the public

In Akumadan a stakeholder meeting was organised twice. The main subjects discussed are fire in the plantation, the possibility for people to do intercropping in Tain II Forest reserve and the public ablution facilities that Form Ghana want to construct at Akumadan.

Form Ghana has signed an intercropping agreement with 28 people in 2014. This number is going down now as the plantation is maturing and most of the terrain is now under canopy cover.

Training and capacity building

Fire education was given in and around the Form Ghana areas.

As the use of fire has become part of their lifestyle, all communities were advised to use fire with great caution. Loss of soil fertility due to fire is widespread as farmers are compelled to use chemical fertilizer to augment crop yields. Community members were advised not to leave any fire unattended to, even before leaving farms for their homes. Recalcitrant members are to be reported to the appropriate authorities for sanctioning and redress. Farmers can ask for free assistance of Form Ghana on fire issues when needed during land preparation.

In general, the communities expressed great appreciation for the collaboration during the yearly fire education program in the communities and also promised to keep fire out of the communities and the forests.

Workers and management of Form Ghana have been trained on various subjects such as the use of phytosanitary products, the application of first aid, fire fighting, nursery techniques, plantation techniques, use of the chain saw, monitoring, GIS mapping and FSC.

The following trainings were provided:

Subject	date	Number of people trained
Monitoring	22 January	9
Teak cutting production	22 January	3
Accounting standards	4 February	6
Security	3 march	8
Mankar spraying	10 March	19
Mankar spraying	21 March	29
Chemical spraying	2 April	4
Stump cutting	22 April	85
Waste management	22 April	8
Map reading	24 April	17
Planting Training	26 April	28
Stump cutting	28 April	42
First Aid	9 May	8
Chemical spraying	27 May	5
Teak seed sowing	9 June	38
Security	16 June	37
Monitoring	14 July	4
Silviculture and Forest Management	21-22 August	21
FSC internal auditing	1 September	9
First Aid	12 September	21
Waste Management	12 September	21
First Aid	19 September	16
First Aid	25 September	7
Payroll Prep & Management Reporting	29 September	6
Ebola Virus Disease	3 October	All workers
Chain saw operations	10-11 October	36

Worker health / accidents on the work floor

The number of people in permanent employment has remained more or less stable. The number of permanent employees was 142 in 2013 and is 135 in 2014 (see table 6).

Table 6. Employees hired by Form Ghana

Contract	2010	2011	2012	2013	2014
Permanent	127	173	182	142	135
Casual	300	400	224	289	268
Total	427	573	406	431	403

Form Ghana has an agreement with the national Health Insurance Company of Ghana, insuring all permanent workers of free access to medical care. An onsite professional nurse assists people not feeling well or injured in the plantation. The nurse can assess the persons, treat them if it is a simple problem or forward them to the hospital in Akumadan or Techiman. The nurse is also responsible for the renewal of the first aid training and for checking the contents of the first aid boxes.

Table 7: dispensary use over the years and per person

Year	2011	2012	2013	2014
Workers	573	406	431	403
Medical attention	1352	1192	971	1163
Interventions / person	2,4	2,9	2,3	2,9

During 2014, medical treatment has been issued 1163 times in Akumadan, which is more than the 971 times in 2013 but similar to the 1192 times in 2012. The number of treatments per person is stable at about 2,5 times per person. The main disease encountered on both locations is malaria. After malaria (222), most treatments were given to people with musculoskeletal pain (173), and cough (135). Typical work related injuries were reported 15 times which is up from 2013 (4 times reported).

1.5 Conclusions

- The planting of Asubima & Afrensu Brohuma has gone quicker than initially planned and all the terrain allocated to Form Ghana has been planted. The area under natural vegetation or indigenous plantation has grown to 493 hectares (14%).
- The annual rainfall was highest (1390 mm) in 2010, decreased in 2011 and decreased again (984mm) in 2012. In 2013, rainfall increased again to 1118mm and in 2014 to 1191 mm, which are about average for the area.
- Growth is better than was expected in some of the areas. However, some of the plots also fall in areas with lower performance than expected. The delay in growth is attributed to weed problems which will be dealt with.
- The activities of Form Ghana have a positive effect on the availability of paid employment in the region. It is perceived as aiding significantly to the restoration of the forest and it's various services.
- The mean growth curve for Akumadan is currently between yield classes 3 and 4.

APPENDIX 1: FORM GHANA PLANTATION DEVELOPMENT

