

Potential Carbon Emission Reductions and Removals from the Ghana Shea Landscape Emission Reductions Project

Summary

The current document summarises the potential emissions reductions and removals from the proposed Ghana Shea Landscape REDD+ Project (GSLRP). With emission reductions and removals over the 7 years of the project estimated at 6.1 mtCO₂e, rising to 25.2 mtCO₂e when a longer 20-year time frame is considered¹. Information and data presented draws primarily from Ghana's FRL submitted to the UNFCCC in October 2017 and currently under revision, as well as the IPCC Good Practice Guidelines (GPG 2003) with additional area specific data added where available and referenced under the specific activity area.

Estimates of impacts are divided into two main areas – those directly associated with Outputs and Activities and cross cutting impacts that are estimated to occur as a result of the full project implementation. This division is made for a number of reasons related to the nature of forest cover and forest cover change within the Northern Savannah Zone (NSZ) of Ghana.

- There has been extensive deforestation in the NSZ over the past 18 years resulting in only small pockets of forest existing outside of protected areas (most notably Mole National Park).
- In many areas deforestation has resulted from conversion of forest land (over 15% crown cover) to grassland – resulting in the creation of over 1.5 million ha of grassland. Many of these recently deforested grassland areas have some tree cover and significant woody vegetation, including root stock, and as such have the potential to regenerate to forest land if pressures on them are reduced or active support to regeneration is provided.
- Forest land remaining outside of Mole National Park is highly fragmented and accurate information on forest cover within target areas of specific activities e.g. establishment of new CREMA areas, is not available. Thus, developing estimates exactly how much forest will be protected from the impacts of the drivers by any specific activity is extremely challenging.

Based on these elements the current assessment has developed output/ activity specific estimations of enhanced removals through actions that will restore forests and enhance carbon stock, namely:

- The transition of 200,000 ha of recently deforested grasslands and heavily degraded forests to open and eventually closed savannah forests through effective management (including early burning and other silviculture practices) of these areas within existing and new CREMA areas under Output 1.
- The transition of 220,000 ha of recently deforested grasslands back to open forest through fire management outside CREMA areas also under Output 1.
- The planting of 1.75 million shea trees and 400,000 other valuable tree species across the NSZ under Output 2.
- The reduction in wood fuel use due to adoption of improved stoves under Output 2 (note this is the one exception within the activity specific estimates as it does focus on reducing emissions as opposed to enhancing removals – specific estimates were however available for this impact).
- The establishment of 25,500 ha of plantations under Output 3.
- The transition of 26,000ha of recently deforested grasslands back to open forest through fire management in areas surrounding plantations under Output 1.

In addition to these areas the project's activities will also result in increased emissions reductions by helping to prevent remaining forest being deforested and degraded. As noted above however, providing accurate assessments of which specific activity will deliver what specific impacts is seen as highly difficult and as such the impacts of all activities on helping to reduce impacts on the remnant forest areas are brought together under the heading of cross cutting emission reductions. This approach is in line with the Warsaw Framework on REDD+, which does not provide a methodology for nor requirement for the attribution of emissions reductions

¹ The longer time frame is utilized to indicate the ongoing impact of the project which is commensurate with actions that involve long term changes in behavior as well as when emission reductions are linked to vegetation growth over time.

to specific activities and further information on the justification for the impact of key activities is provided in section 6 within the current document. Critically, these emission reductions are considered separate from the activity specific removals as they focus on reduced impacts to existing forest areas as opposed to removals from the return of non-forest areas (predominantly grassland) to forest areas.

A summary of the proposed project structure and estimated emissions reductions and removals is provided in the table below. These emission reductions would not be achieved without GCF Funding as has been ascertained in the funding proposal and are therefore additional. The proposal makes a case for a grant on the basis of the following inter-related elements: (i) All the project components target barriers which need to be addressed within public expenditure frameworks; these include start up financing to set up community forest management systems and to plant shea at scale, effective fire management at scale, aggregation and storage of shea kernels and benefit sharing in the Modified Taungya Systems. Private sector actors will not engage with single dispersed farmers and trees or in community forests. (ii) The current state of Ghana's public finances (e.g., limitations to government taking on concessional debt in the current challenging macroeconomic circumstances), such public expenditures can now only come from international grants.

In the Accreditation Master Agreement signed between the GCF and all accredited entities, there is a standard clause on Intellectual Property; Ownership of Equipment; Entitlement to Emission Reductions (Clause 23). Paragraph 23.05 mentions that unless otherwise so provided under the terms of the FAA with respect to a Funded Activity, the Accredited Entity shall, to the extent permitted by the applicable laws and regulations, contractually ensure (including in any agreement with an Executing Entity) that any greenhouse gas emission reductions (e.g. in emissions by sources or an enhancement of removal by sinks) achieved by the Funded Activity shall not be converted into any offset credits or units generated thereby, or if so converted, will be retired without allowing any other emissions of greenhouse gases to be offset.

Output	Key Targets:	Removals and Reductions in Emissions during project lifetime	Removals and Reductions in Emissions during 20 years
1. Off-reserve savannah forest restored through self-financing community management in CREMA	Expansion of fully devolved CREMA area by 300,000 Place 200,000 of heavily degraded forest and grassland under sustainable forest management Further 220,000 ha in which communities adopted improved fire management techniques	1,271,899 tCO ₂ e from management for wood fuels 905,952 tCO ₂ e from fire management	4,019,034 tCO ₂ e from management for wood fuel 3,067,915 tCO ₂ e from fire management
2. Degraded shea parklands restored through public private partnerships	Planting of 1.75million shea trees and 400,000 other valuable trees Increase value of shea industry Reduce overall industry wood fuels consumption by	58,520 tCO ₂ e from shea planting 165,135 mtCO ₂ e from reductions in wood fuels use	375,503 tCO ₂ e from shea planting 522,927 mtCO ₂ e from reductions in wood fuels use
3. Forest Reserves Restored through MTS plantations and effective fire management	Establishment of 25,500ha of MTS plantations Establishment of a sustainable financing system based on MTS 26,000ha surrounding plantations of improved fire management	1,012,958 tCO ₂ e from MTS and plantations 342,471 tCO ₂ e from improved regeneration of natural forest due to fire management	5,576,155 tCO ₂ e from MTS and plantations 1,614,505 tCO ₂ e from improved regeneration of natural forest due to fire management
4. Integrated monitoring		No direct emissions reductions – contribution through	

system implemented and REDD+ system strengthened		improved forest management information that will help in implementation of all outputs and delivery of cross cutting emission reductions.	
5. Project Management		No direct emission reductions	
A number of cross cutting impacts have also been identified these come from actions across outputs:	Based on 15% reductions in agricultural expansion, conversion to grassland (equating to 6,842ha of avoided loss each year) and degradation due to timber harvesting and fire. These impacts will be achieved incrementally over the project implementation period	2,040,843 tCO ₂ e from reductions in deforestation 341,656, tCO ₂ e from reductions in degradation	8,673,581 tCO ₂ e from reductions in deforestation 1,452,038 tCO ₂ e from reductions in degradation
Total Emission reductions:		6,135,670 tCO₂e	25,248,972 tCO₂e

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1 Introduction

This document presents an assessment of the impacts of the proposed project activities on levels of emissions and removals from the forest sector within the Northern Savannah Zone of Ghana.

Information and data presented draws primarily from Ghana's FRL submitted to the UNFCCC in October 2017 and currently under revision, as well as the IPCC Good Practice Guidelines (GPG 2003) with additional area specific data added where available and referenced under the specific activity area.

Information on emissions reductions and removals is presented primarily by output to facilitate links with the Funding Proposal (FP) with a number of cross cutting impacts also identified and detailed after the output specific impacts. Baseline data sources presented below to provide context.

2 Baseline Data:

2.1 On- and Off-Reserve Forest:

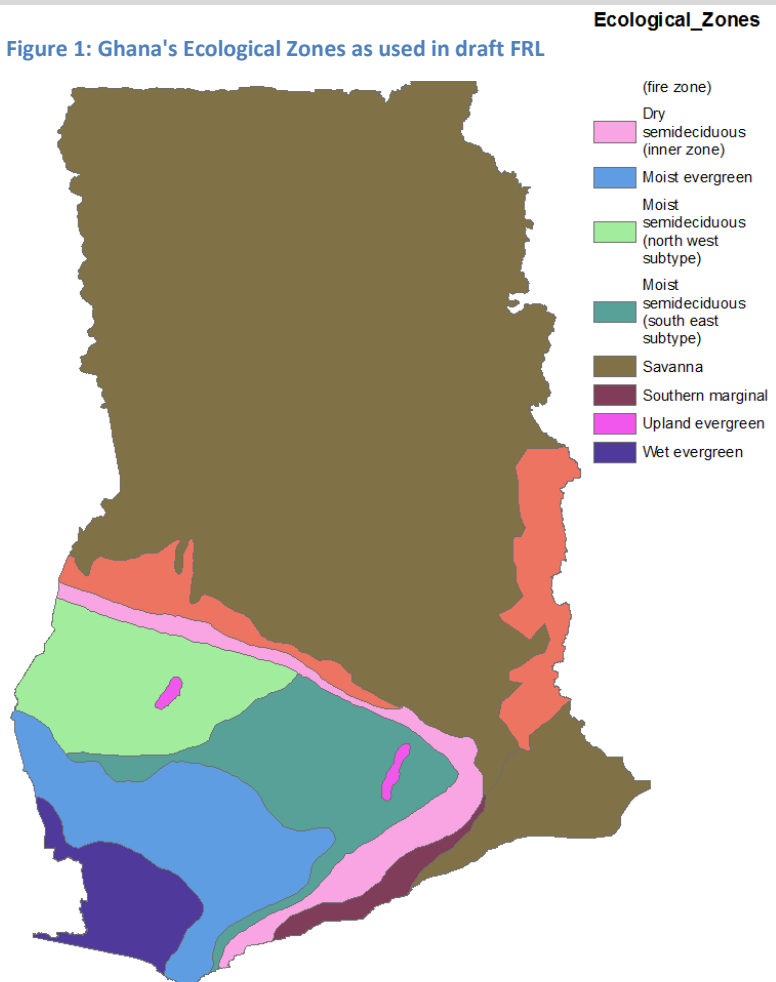
Ghana's forests are divided between on and off reserve areas. On reserve areas refer to areas gazetted by the government for a range of purposes including timber production and biodiversity conservation. Off reserve areas are forest areas that exist outside of these gazetted areas.

2.2 Definition of forest

Following Ghana's National REDD+ Strategy², the definition used for Ghana's forest definition is a minimum of **15% canopy cover, minimum height of 5 meters, and minimum area of 1 hectare**, based on thresholds set by the IPCC for these structural parameters and the Marrakesh Accord. This definition is in line with the definition used in the most recent National Greenhouse Gas inventory.³

In Ghana's context, agricultural tree crops, including cocoa, citrus, oil palm (in smallholder or estate plantations), and rubber are not considered to be forest trees. Timber tree plantations are considered forest under the national forest definition. Areas with over 15% of canopy cover of "forest trees" (trees not defined as agricultural crops) that are also used for agricultural purposes such as areas of shea agroforestry parklands are classified as forests under this definition.

Figure 1: Ghana's Ecological Zones as used in draft FRL



²GoG, 2015. National REDD+ Strategy.

³ Republic of Ghana, National Greenhouse Gas Inventory Report, July 2015. Table 72.

2.3 Forest Type

The forests of the entire project zone are classified as savannah woodland (see Figure 1) based on a combination of field surveys and data from the Forest Preservation Programme (FPP), which, worked on looking at the transformation of the country's forests between 1990 and 2010. The three regions of the Northern Savannah Zone (NSZ) make up 61.5% of this area (9.77 m ha of 15.89 m ha).

Box 1 below provides the description of savannah forest while Box 2 provides a description of the two sub-categories of forest used within the FRL. The relative carbon contents of these forest types are provided in Table 1.

Box 1: Savannah Woodland Description as given in FRL

Woodland vegetation found in the northern and coastal savannah of Ghana. Northern savannah is mainly woodlands and grass mosaic. Trees can grow above 5 meters. However, along rivers and streams, the tree height can reach up to 20 meters and usually forms a closed canopy. The forest in this zone is fire prone, and fire is sometimes used as management for the range lands.

Box 2: Definitions of Closed and Open canopy forest as provided in FRL

Closed canopy forest

Under the Forest Preservation Programme Ghana's forest was classified according to the extent of canopy cover. The closed canopy forests are those with canopy cover exceeding 60%. It exhibits typical high forest characteristics with a 3-layer vertical structure namely; the upper, middle and ground layers. They are mainly found in the gazetted forest reserves and national parks of Ghana. This category of forest according to the Resource Management Support Centre (RMSC) categorization which is based on the amount of light that penetrates the forest floor and is referred to as condition score varying from 1 to-6 in order of good to bad condition, have condition score 1 and 2.

Open canopy forest

This is modified or disturbed natural forest which has 15 - 59 % canopy cover (FPP, 2010.) They may also have a three vertical layer structure: an upper layer, which, is made up of isolated mature trees; the middle layer is made up of saplings and shrubs; and a ground layer, which, is dominated by grass. In most instances, the middle and ground layers are merged and constitute the dominant layer in the open forest.

Table 1: Carbon Stock of key land uses in Ghana NSZ - information from Ghana draft FRL

Land use type	Carbon Stock per ha tCO ₂ e
Closed Forest	17.73
Open Forest	13.09
Cropland	9.82
Grassland	12.00

Based on the above data, levels of carbon stock for other land uses and data on annual land use change, the following levels of average annual emissions were calculated for Ghana's Savannah forests, as part of the development of the country's FRL. A summary of this data is provided in Table 2.

Table 2: Emission Factors for conversion between land use types within Ghana's Savannah Forest with annual average levels of forest loss and associated emission levels (Data from updated assessment of NSZ conducted November 2017⁴)

Land use change		EF (tCo2e / ha)	Conversion (ha per year) 2001-15	Average Annual Emissions
Closed forest	Cropland	163	238	38,752
Closed forest	Grassland	32	1,416	45,703
Closed forest	Wetlands	82	1	49
Closed forest	settlement	138	8	1,071
Closed forest	Bareland/other	227	15	3,315
Closed forest	Water	0	56	0
Open Forest	Cropland	157	12,333	1,934,737
Open Forest	Grassland	26	55,755	1,463,570
Open Forest	Wetlands	76	39	2,987
Open Forest	settlement	132	344	45,334
Open Forest	Bareland/other	221	149	32,883
Open Forest	Water	0	212	0
		Totals:	70,566	3,568,400

Key conversion values used within calculations for the above table and within this document include:

- Conversion of Dry Biomass to Carbon: *0.47
- Conversion of Carbon to Carbon Dioxide: *44/12

3 Output 1: Off reserve, degraded, savannah forests restored under self-financing community management in CREMA.

Impacts for all activities were calculated for the 7-year project duration as well as a longer 20-year time period which represents the ongoing emissions reductions and removals the project will deliver.

3.1 Removals due to Forest Regeneration within areas of forest within CREMAs under management for production of wood fuels:

Activity:

Output 1: Off reserve, degraded, savannah forests restored under self-financing community management.

- Activity 1.1 structure and empower Communities for savannah forest management
- Activity 1.2 Sustainable forest management systems developed and adapted to local conditions
- Activity 1.3 Enterprise and value chain development
- Activity 1.5 Enabling and support measures for community management of forests

Context and Basis of Carbon Impacts: There are large areas of 'natural forest' that have been heavily degraded and in some cases deforested to be classified as grassland. Many of these areas, however, continue to have significant woody vegetation as well as young stems and have the potential for regeneration if widespread disturbance is halted⁵.

Communities organised through the CREMA structure (Activity 1.1.) will be able to work together to undertake effective forest management activities to regenerate deforested grasslands into forest areas once provided with training on forest management techniques (Activity 1.3.) The long-term sustainability of these activities and incentives for communities to undertake these activities are based on both the increased resource security

⁴ Data developed during an update assessment conducted in November 2017 with Winrock International and Ghana FC. Information from the session is as yet unpublished

⁵ Information on condition of degraded and deforested reserve areas is provided in Forestry Commission & IUCN (2016) Validating criteria for savannah condition score assessment in Ghana

achieved through the structures (further strengthened through legislative reforms within Activity 1.5) and the income that can be generated through sustainable charcoal production and fuelwood collection within the areas (Activity 1.3.).

Baseline Data:

Area of impact: 200,000ha of recently deforested grassland areas placed under management during project.

Baseline carbon stock in grassland areas: ABG carbon stock of 12tCha⁻¹ ⁶.

Growth rate of forest: African dry forest <20 years 2.4 tonnes dry matter per ha⁷ = 1.128 tC per ha = 4.136 tCO₂e/ha

Discount for early dry season burning – No discount is applied as research has indicated that early burning can actually have an overall positive impact on net growth rates⁸.

Discount for harvesting of wood fuels - 10% is harvested annually for wood fuels at an intensity that removes 50% of all ABG carbon stock.⁹

Impacts:

The table below shows a summary of the expected impacts of project activities on levels of regeneration within the target areas.

Table 3: Impacts of removals due to forest regeneration within areas of forest within CREMAs under management for charcoal production

Year	Area (ha)	Existing C stock of area added	Existing C stock of area under management	Annual increase in ABG carbon stocks	Total C stock at end of year	Annual harvest wood fuel harvest (50% of 10% of the total stock) (tC)	Total carbon stock at end of year (tC)	Net Carbon Increase (tC)	Net CO ₂ Sequestered (tCO ₂ e)
1	NA		NA	0		NA	NA	NA	NA
2	25,000	300,000	0	28,200	328,200	- 16,410	311,790	11,790	43,230
3	75,000	600,000	312,315	84,600	996,390	- 49,820	946,571	34,781	127,529
4	125,000	600,000	948,768	141,000	1,687,571	- 84,379	1,603,192	56,621	207,612
5	175,000	600,000	1,608,393	197,400	2,400,592	-120,030	2,280,562	77,370	283,691
6	200,000	300,000	2,290,264	225,600	2,806,162	-140,308	2,665,854	85,292	312,737
7	200,000			225,600	2,891,454	-144,573	2,746,882	81,027	297,100
8	200,000			225,600	2,972,482	-148,624	2,823,857	76,976	282,245
9	200,000			225,600	3,049,457	-152,473	2,896,985	73,127	268,133
10	200,000			225,600	3,122,585	-156,129	2,966,455	69,471	254,726
11	200,000			225,600	3,192,055	-159,603	3,032,453	65,997	241,990
12	200,000			225,600	3,258,053	-162,903	3,095,150	62,697	229,890
13	200,000			225,600	3,320,750	-166,037	3,154,712	59,563	218,396
14	200,000			225,600	3,380,312	-169,016	3,211,297	56,584	207,476
15	200,000			225,600	3,436,897	-171,845	3,265,052	53,755	197,102
16	200,000			225,600	3,490,652	-174,533	3,316,119	51,067	187,247
17	200,000			225,600	3,541,719	-177,086	3,364,633	48,514	177,885

⁶ GoG (2017) Draft Forest Reference Emission Level

⁷ Based on IPCC Good Practice Guidelines (2003)- Table 4.9 above ground net biomass growth in natural forests and Table 4.4 - Calculation steps for tier 1 – 4.36. Note that there are 0.47 tonnes Carbon per Tonne Dry Matter

⁸ Information based on Burkina Faso Ministry of Environment, Green economy and Climate Change (2016) Literature Review on Impact of Fire on the Productivity of Forest Areas

⁹ Based on expert opinion

18	200,000			225,600	3,590,233	-179,512	3,410,722	46,088	168,991
19	200,000			225,600	3,636,322	-181,816	3,454,506	43,784	160,541
20	200,000			225,600	3,680,106	-184,005	3,496,100	41,595	152,514
						Mid-term (4 years)			378,371
						Total impact 7 years:			1,271,899
						Total Impact 20 years:			4,019,034

3.2 Removals due to forest regeneration in areas outside of CREMA management due to improved fire management through partial burning activities:

Activity:

Output 1: Off reserve, degraded, savannah forests restored under self-financing community management.

- Activity 1.2 Sustainable forest management systems developed and adapted to local conditions
- Activity 1.4 Off Reserve (non-CREMA) Forest Restoration through fire management

Context and Basis of Carbon Impacts:

There are large areas of 'natural forest' that have been heavily degraded and in some cases deforested to grassland with the FRL reporting over 1.5m ha transitioning from forest to grassland during the 15 years from 2001-15¹⁰. These areas, however, continue to have significant woody vegetation as well as young stems and have the potential for regeneration if widespread disturbance is halted¹¹. The most widespread disturbance that prevents regeneration of these areas is fire with late dry season fires being estimated to result in the loss of between 4.6 (in savannah woodland) and 10 (in grasslands) tonnes of dry matter (t d.m) per ha¹² – significantly higher than the growth rate of 2.4 t d.m. per ha for savannah forest areas¹³. Implementation of early burning techniques in a mosaic across existing areas will help to reduce the number and spread of these mid and late dry season fires reducing both the area and impact of burning across the landscape (early season fires are noted to result in the loss of only 2.6 t d.m. per ha).

By developing effective early burning techniques (Activity 1.2.) and conducting a widespread awareness campaign as well as trainings to communities (Activity 1.3.) combined with demonstration activities and successful implementation within CREMA areas, communities across the landscape will adopt early burning practices. While these will help to reduce deforestation and forest degradation they will be more critical in supporting forest regeneration of areas no longer classified as forest but that has the potential to return to forest if high impact land season fires can be removed from the system.

Baseline Data:

Target area: 220,000 ha of recently (past 15years) deforested grassland areas in off reserve lands that are not currently under management.

Baseline carbon stock in grassland areas: ABG carbon stock of 12tCha⁻¹ ¹⁴.

Growth rate of forest: African dry forest <20 years 2.4 tonnes dry matter per ha¹⁵ = 1.128 tC per ha = 4.136 tCO₂e

Discount for early dry season burning – No discount is applied as research has indicated that early burning can actually have an overall positive impact on net growth rates¹⁶.

¹⁰ Ibid

¹¹ Information on condition of degraded and deforested reserve areas is provided in Forestry Commission & IUCN (2016) Validating criteria for savannah condition score assessment in Ghana

¹² Impact of early season dry season burns of savannah woodlands taken from Table 3A.13 Biomass consumption (t/ha) values for fires in a range of vegetation types of Annex 3A.1 of the IPCC Good Practice Guidelines (2003)

¹³ Based on IPCC Good Practice Guidelines (2003) Table 4.9 - Above ground net biomass growth in natural forests table 4.4.

¹⁴ GoG (2017) Draft Forest Reference Emission Level

¹⁵ Based on IPCC Good Practice Guidelines (2003)- Table 4.9 above ground net biomass growth in natural forests and Table 4.4 - Calculation steps for tier 1 – 4.36. Note that there are 0.47 tonnes Carbon per Tonne Dry Matter

¹⁶ Information based on Burkina Faso Ministry of Environment, Green economy and Climate Change (2016) Literature Review on

Discount for ongoing impacts of other drivers of deforestation and forest degradation – the below provides estimates based on the main drivers of deforestation and forest degradation.

- *Logging* – No discount applied as it is assumed that as the areas are already deforested there is no merchantable timber available.
- *Fire* – It is assumed that the burning process will not be fully effective and that 10% of the area will be impacted by late dry season fires, which, will result in a loss of 4.6 t d.m. per ha¹⁷
- *Wood fuel harvesting* - 10% is harvested annually for wood fuels at an intensity that removes 50% of all ABG carbon stock.
- *Conversion to agriculture* – The FRL identifies that on average 34,000ha of savannah forest was lost to agriculture per year during the reference period. If taken as a percentage of total savannah forest cover in 2001 this equates to a 1.3% rate of annual forest loss. This level of percentage loss is thus conservatively assumed to occur over the project period¹⁸. This impact is included as wider fire management practices under Activity 1.4 are not linked with any other land use planning or management and thus conversion is estimated to continue. Conversely under 1.2 land use planning within CREMA's will help to reduce this conversion.

Impacts:

The project will reduce the impacts of fire over 220,000ha of recently deforested grassland allowing it regenerate to savannah forest.

Table 4: Impacts of removals due to Forest Regeneration in areas outside of CREMA management due to improved fire management through partial burning activities

Year	Area (ha)	Area remaining after agriculture loss (ha)	Total Existing C stock (tC)	Annual increase in ABG carbon stocks (tC)	Loss from late season burns (tC)	Loss from annual harvest (10% of area at 50%) (tC)	Total carbon stock at end of year (tC)	Net Carbon Increase (tC)	Net CO2 Sequestered (tCO _{2e})
1	0			0				0	
2	20,000	19,740	236,880	22,267	2,006	12,857	244,284	7,404	27,147
3	60,000	59,220	718,044	66,800	6,018	38,941	739,885	21,841	80,085
4	100,000	98,700	1,213,645	111,334	10,029	65,747	1,249,202	35,557	130,375
5	140,000	138,180	1,722,962	155,867	14,041	93,239	1,771,549	48,587	178,151
6	180,000	177,660	2,245,309	200,400	18,053	121,383	2,306,273	60,965	223,538
7	220,000	217,140	2,780,033	244,934	22,064	150,145	2,852,758	72,724	266,656
8	220,000	217,140	2,874,822	244,934	22,064	154,885	2,942,807	67,984.87	249,278
9	220,000	217,140	2,964,872	244,934	22,064	159,387	3,028,354	63,482.41	232,769
10	220,000	217,140	3,050,418	244,934	22,064	163,664	3,109,623	59,205.06	217,085
11	220,000	217,140	3,131,688	244,934	22,064	167,728	3,186,830	55,141.59	202,186

Impact of Fire on the Productivity of Forest Areas

¹⁷ Impact of early season dry season burns of savannah woodlands taken from Table 3A.13 Biomass consumption (t/ha) values for fires in a range of vegetation types of Annex 3A.1 of the IPCC Good Practice Guidelines (2003)

¹⁸ Figure for conversion of forest to agricultural land used as there is no corresponding data on conversion for grassland to agriculture. It is also assumed that with improved forest management, forest conversion for agricultural expansion linked to population growth will be halted and targeted towards conversion of grassland to cropland.



12	220,000	217,140	3,208,894	244,934	22,064	171,588	3,260,175	51,281.28	188,031
13	220,000	217,140	3,282,240	244,934	22,064	175,255	3,329,854	47,614.00	174,585
14	220,000	217,140	3,351,918	244,934	22,064	178,739	3,396,048	44,130.07	161,810
15	220,000	217,140	3,418,113	244,934	22,064	182,049	3,458,933	40,820.35	149,675
16	220,000	217,140	3,480,998	244,934	22,064	185,193	3,518,674	37,676.11	138,146
17	220,000	217,140	3,540,738	244,934	22,064	188,180	3,575,427	34,689.08	127,193
18	220,000	217,140	3,597,492	244,934	22,064	191,018	3,629,343	31,851.40	116,788
19	220,000	217,140	3,651,408	244,934	22,064	193,714	3,680,563	29,155.61	106,904
20	220,000	217,140	3,702,628	244,934	22,064	196,275	3,729,222	26,594.60	97,514
							Mid-term (4 years)		237,607
							Total impact 7 years:		905,952
							Total impact 20 years:		3,067,915

4 Output 2: Degraded shea parklands restored through public private partnerships

4.1 Planting of shea:

Activity:

Output 2: Degraded shea parklands restored through public private partnerships

- Activity 2.1 Restore and sustainably manage shea parklands
- Activity 2.2 Strengthen value chains for shea processing
- Activity 2.3 Enhancing enabling environment for climate-smart shea and upscaling of finance and investments

Context and Basis of Carbon Impacts:

Planting shea is not currently practiced within communities with regeneration only occurring through natural regeneration. One project is currently working to initial efforts towards the planting of shea but this remains at an early stage and the current project will work with it to achieve economies of scale in shea planting.

Currently, cultural barriers related to not planting shea trees combined with a lack of secure tenure over planted forest trees, limited knowledge and awareness of the potential for planting of shea and options to improve growing stock have resulted in almost no planting of shea.

It is expected that, individuals will seek to obtain and plant shea trees and thus demand for shea nuts through increasing communities' awareness and understanding of the opportunities for planting shea both in traditional agroforestry systems and along field edges through awareness and information campaigns (Activity 2.1.), access to shea stock through a programme of nurseries and technical support (Activity 2.2.), and increased support to shea value chain (Activity 2.3.).

Note: The impacts of actions under this output that result in a reduction in the rate of forest loss are covered within cross cutting actions, which follows the outputs. The two different impacts are presented separately as impacts on reductions in deforestation and forest degradation are addressed by a number of activities across the four outputs of the proposal with direct attribution to any one activity not seen as possible. This approach is in line with the Warsaw Framework on REDD+, which does not provide a methodology for nor requirement for the attribution of emissions reductions to specific activities.

Baseline Data:

Target area: The project will work with communities in agroforestry systems across the NSZ with a focus on those in CREMA areas, those surrounding forest reserves and those areas that have seen an increase in levels of shea clearing.

Growth rate of shea:

A growth rate of 0.0038 t/C/ha/yr has been used based on studies in Mali due to limited data on growth rates in Ghana (data is summarised in the table below, adapted from Sanogo et al (2016)¹⁹)

No failure rate for shea is included within the below calculations as these are already built in with regard to an anticipated 50% level of mortality at seedling level and an estimation that 250,000 of seedling planted out will fail (12.5%). As such the proposed number of trees planted will total 2 million of which 1.75 million are anticipated to survive²⁰.

¹⁹ Sanogo et al (2016) Potential of dendrochronology in assessing carbon sequestration rates of *Vitellaria paradoxa* in southern Mali, West Africa. *Dendrochronologia* 40 (2016) 26–35

²⁰ Estimated level of failure based on expert opinion through the Global Shea Alliance

Table 5 Growth rates of Shea trees

Mali	Precipitation – mm/year	Land use	Shea density	C sequestered t/ha/yr	C stock/ha	CO ₂ stock t/ha	CO ₂ Seq t/ha/year
Koutilala	889 +/- 173	Parkland	16	0.068	3.81	14.0	0.25
		Fallow	13	0.053	3.43	12.6	0.19
Yanfolila	1126 +/-174	Parkland	27	0.112	4.15	15.2	0.41
		Fallow	23	0.075	3.4	12.5	0.28
		Protected	18	0.064	3.47	12.7	0.23
Mean	1007.5		19.40	0.07	3.65	13.39	0.27
			Per tree	0.0038	0.1882	0.6902	0.0141

Impact

The project will plant 1.75 million shea trees across the landscape.

Table 6 Impacts of Planting Shea trees

Year	Tress	Mean Annual Growth (c/tree/yr)	Total Annual Increase in Carbon Stock (tC/yr)	CO ₂ Sequestered
1		0.0038	0	0
2	20,000	0.0038	57	279
3	80,000	0.0038	247	1,115
4	350,000	0.0038	1,007	4,877
5	750,000	0.0038	1,900	10,450
6	1,250,000	0.0038	2,850	17,417
7	1,750,000	0.0038	3,800	24,383
8	1,750,000	0.0038	3,800	24,383
9	1,750,000	0.0038	3,800	24,383
10	1,750,000	0.0038	3,800	24,383
11	1,750,000	0.0038	3,800	24,383
12	1,750,000	0.0038	3,800	24,383
13	1,750,000	0.0038	3,800	24,383
14	1,750,000	0.0038	3,800	24,383
15	1,750,000	0.0038	3,800	24,383
16	1,750,000	0.0038	3,800	24,383
17	1,750,000	0.0038	3,800	24,383
18	1,750,000	0.0038	3,800	24,383
19	1,750,000	0.0038	3,800	24,383
20	1,750,000	0.0038	3,800	24,383
			Mid-term (4 years)	6,270
TOTAL			Total project life	58,520
			20 year total:	375,503
Conversion of C to CO ₂		3.66666667		

Other Tree Species

Calculations are based on IPCC default growth rate for indigenous species.

	Number of trees	Spacing for indigenous species	Trees per ha for indigenous species	Hectares for 400,000 trees	Survival rate
Year 1	57'142.86		69.44444	822.86	50%
Year 2	57'142.86	12*12	69.44444	822.86	50%
Year 3	57'142.86	12*12	69.44444	822.86	50%
Year 4	57'142.86	12*12	69.44444	822.86	50%
Year 5	57'142.86	12*12	69.44444	822.86	50%
Year 6	57'142.86	12*12	69.44444	822.86	50%
Year 7	57'142.86	12*12	69.44444	822.86	50%

Variable	Area	Discounted Area	Gw	R (included in Gw estimate)	GTOTAL	CF	ΔCG
Explanation of variable	Area planted	Area planted discounted by the survival rate	average annual above-ground biomass growth for a specific woody vegetation type	Ratio of ABG to BGB (Eq 2.10).	Average annual biomass growth for AGB and BGB (Eq 2.10)	Carbon fraction (Eq. 2.9)	Annual increase in carbon stocks due to growth on converted land (output of Eq. 2.10, input to Eq. 2.15).
Unit	ha	ha	ton d. m. ha ⁻¹ year ⁻¹	(ton d.m. biomass)-1	ton d. m. ha ⁻¹ year ⁻¹		ton C yr ⁻¹
Equation			Gw = (C total forest type / rotation length)		GTOTAL = (Gw * (1+R))		A _{TO_OTHERS} * GTOTAL * CF

Data Source		Plantation department	C total forest type: NON-TEAK: IPCC AFOLU Vol. 4 table 4.8	IPCC 2006 (Mokany et al. 2006 R of BGB to AGB for tropical moist deciduous forest >125 t dry matter per ha)		IPCC 2006	
Year 1		411.43	5.37			0.47	3'809.11
Year 2		411.43					7'618.23
Year 3		411.43					11'427.34
Year 4		411.43					15'236.46
Year 5		411.43					19'045.57
Year 6		411.43					22'854.69
Year 7		411.43					26'663.80

4.2 Reduced degradation from wood fuels harvesting:

Activity:

Output 2: Degraded shea parklands restored through public private partnerships

- Activity 2.2.3 Reduction of wood fuel consumption and development of the know-how to achieve energy and water use efficiencies;

Context and Basis of Carbon Impacts:

Shea processing is practiced across the NSZ predominantly in rural areas. While it provides many pro-poor benefits current production methods require significant inputs of fire wood with studies indicating that as much as 50% of all fire wood consumed in rural areas during shea harvesting time is for shea processing. Research and field tests have also indicated that there is the potential to reduce this level of wood fuels consumption by between 70-90% through adoption of improved technologies and processing techniques.

The current activities will work with processing groups to improve efficiency of wood fuels use by adoption of improved techniques such as improved stoves, reduced boiling times and other methods.

Baseline Data:

Level of wood fuels use in shea production: Estimates of level of wood fuels used in shea production vary across the research²¹:

For butter, wood fuels use varies from 1.3 kg per kg of shea butter in urban areas to 1.9 kg per kg of shea butter in rural areas. A value of 1.6 kg was used for the below calculations.

For kernel, wood fuels use varies from 0.58 to 0.76 kg per kg of kernel almost all of which is processed in rural areas. A value of 0.67 kg per kg of kernel was thus used.

Dry wood fuels to biomass: It is estimated that for every kg of wood fuels used, 1.3 kg of biomass is needed²².

Levels of shea production: There is limited information available on total shea production in Ghana. Levels of export, however, are estimated to be in the region of 50,000 tonnes of kernel and 1,000 tonnes of shea butter²³. As interventions will target the export market these figures are taken as a baseline.

Impacts:

A number of studies have shown the potential for the adoption of improved methods to achieve reductions in wood fuels use of between 70% and 90% with efficiencies in use of stoves and processing approaches²⁴. A conservative estimate of 70% is used within the assessment of impact, with the project having this impact with 50% of producers working in the export market. The period of time used for the estimate is 6 years based on no significant reductions being achieved in Y1 of the project a longer-term estimate of 20 years is also provided based on the ongoing impact of the interventions.

Table 7 Impacts of reduced degradation due to sustainable harvesting of wood fuels for shea production

Product	Exports (t)	Percentage of market impacted by project	Ratio of wood fuels to shea product	Tonnes of Wood fuels used in BAU (t d.m.)	In field biomass needed for wood fuels (t d.m.)	In field carbon needed for fuelwood (tC)	Project Reduction	Reduced emissio ns (CO ₂)
Raw kernel	50,000	25,000	0.67	16,750	21,775	10,234	7,164	26,268
Butter	1,000	500	1.6	800	1,040	489	342	1,255
						Total annual reduction:		27,522
					Mid-term (4 years)			82,567
					Total project reduction ²⁵ :			165,135
					Total over 20 years:			522,927

²¹ The range of values cited comes from Jasaw G, Saito O, Gasparatos A, Shoyama K, Bofo Y, Takeuchi K (2017) Ecosystem services trade-offs from high fuelwood use for traditional shea butter processing in semi-arid Ghana *Ecosystem Services* 27 (2017) 127–138, with this data also cross referencing with SNV (2013) Behind the Butter: An Energy Analysis of shea Butter Processing which indicates 1.7kg wood fuels per kg of shea butter.

²² Ballis R, Drigo R, Ghilardi A, Masera O (2015) The Carbon Footprint of Traditional Wood fuels, *Nature Climate Change* 5, 266–272

²³ Export values from USAID (2010) Investing in shea in West Africa available from http://pdf.usaid.gov/pdf_docs/Pnadu686.pdf

Global Shea Alliance The Shea Industry's Economic Impact in Africa available at http://globalshea.com/uploads/files/nyc_shea_trade_and_industry_conference_presentations/lovett_nyc_global_shea_may_2013_75.pdf

²⁴ Naughton C, Zhang Q, Mihelcic J (2017) Modelling energy and environmental impacts of traditional and improved shea butter production in West Africa for food security *Science of The Total Environment* Volume 576, 15 January 2017, Pages 284–291, estimate that a 78% reduction in wood fuels use can be achieved through improved cookstove use with USAID AGNRM project also experimenting with a stove that reports to give 80% reductions in wood fuels use (USAID pers comms), significant benefits can also be achieved through reducing the boiling time of shea kernel (P Lovett pers comms).

²⁵ Based on impact being over 6 years with the first year required to initiate interest in improved approaches.

5 Output 3: Modified Taungya System plantations and fire management in forest reserves

5.1 Establishment of MTS plantations

Activities:

Output 3: Forest cover restored in forest reserves through MTS plantation and fire management

- Activity 3.1 Structure MTS communities with clearly defined contractual and benefit sharing arrangements
- Activity 3.2 Establish, maintain and monitor MTS Plantations
- Activity 3.3 Promote fire management and control for plantation protection and for the restoration of savannah forests in the reserves

Context and Basis of Carbon Impacts:

The GoG's Forest Plantation Strategy (FPS) 2016-2040 identifies over 280,000ha of reserves in the NSZ (70% of the total) as suitable for plantation development. This is compared to the area currently under plantation which is just 2,553ha²⁶.

Reserve areas are also heavily degraded and in many areas deforested with the trend of loss continuing due to limited management, illegal harvesting of timber and wood fuels and vulnerability to fires. This has already resulted in many reserve areas being largely deforested with a recent assessment of four reserves in the NSZ indicating identify average canopy cover of just 20%²⁷.

The MTS has been demonstrated to be an effective system to engage communities living around reserves to engage in plantation development and protection. The project will work with communities surrounding reserves to establish MTS groups (Activity 3.1.) and undertaken plantation development and subsequent management including fire management around plantation areas (Activity 3.2. and activity 3.3).

Baseline Data and Assumptions:

Target areas: Deforested areas of reserves within the NSZ

Growth rate of forest:

A figure of 7.875 t d.m. per ha per annum is used in the impact assessment with information coming from unpublished field trials of *Gmelina arborea* by Africa Plantations for Sustainable Development. This figure is in line with default values for IPCC²⁸ as follows;

- African dry forest - Africa Eucalyptus sp <20 years 13 tonnes dry matter per ha = 6.11 tC per ha = 22.4 tCO₂e
- African dry forest – Africa “other” <20 years 10 tonnes dry matter per ha = 4.7 tC per ha = 17.23 tCO₂e

Failure rate – it is anticipated that 25% of plantings will fail due to fire or other environmental conditions throughout their life²⁹.

Below ground biomass (BGB) – a ratio of 0.26 of BGB to Above Ground Biomass (ABG) is used based on IPCC default values for dry forest areas³⁰. *Thinning* – Thinning will be required in the 4th and 8th year after planting with 50% of biomass removed at this point³¹. *Harvesting* – harvesting will occur after 12 years with areas clear felled. It is anticipated that root stock will however allow for regrowth to occur without subsequent replanting³².

²⁶ Forestry Commission Ghana (2016) Forest Plantation Development Strategy 2016-2040

²⁷ FC RMSC and IUCN (2017) Validating criteria for savannah condition score assessment in Ghana

²⁸ Based on IPCC GPG (2006) Table 4.10 Above ground net biomass growth in forest plantations. Calculation steps for tier 1 – 4.36 note that there are 0.47 tonnes Carbon per Tonne Dry Matter

²⁹ Based on expert opinion from Ghana Forestry Commission and representatives of plantation development companies.

³⁰ Based on IPCC GPG (2006) Table 4.4 Ratio of Below Ground Biomass to Above Ground Biomass

³¹ Based on expert opinion

³² Ibid

Impacts:

The project will plant 25,500ha of plantation through MTS (18,500 ha) and plantations (7,000 ha) that will be established and managed with hired labour. The Forestry Commission will manage this additional 7,000 hectares through its co-financing funds.

Table 8 Impacts of Plantation establishment

Year	Area (ha)	Mean Annual Biomass Growth (dm/ha/yr)	Annual Increase in biomass (dm/yr)	25% failure	Net AGB increase (tones dm)	Below ground biomass	First thinning	Second thinning	Harvest	Regrowth (including AGB and BGB and 10% failure)	First thinning of second rotation	Total Biomass	Net Biomass increase	Net CO2 Sequestered per annum
1	1,000	7.875	7,875	1,969	5,906	1,654	0					7,560	7,560	13,028
2	4,000	7.875	31,500	7,875	23,625	6,615	0					37,800	30,240	52,114
3	8,000	7.875	63,000	15,750	47,250	13,230						98,280	60,480	104,227
4	13,000	7.875	102,375	25,594	76,781	21,499	10,395					186,165	87,885	151,455
5	18,000	7.875	141,750	35,438	106,313	29,768	10,395					311,850	125,685	216,597
6	22,000	7.875	173,250	43,313	129,938	36,383	41,580					436,590	124,740	214,969
7	25,500	7.875	200,813	50,203	150,609	42,171	41,580					587,790	151,200	260,568
8	25,500	7.875	200,813		200,813	56,228	41,580	16,216				787,034	199,244	343,363
9	25,500	7.875	200,813		200,813	56,228	41,580	16,216				986,278	199,244	343,363
10	25,500	7.875	200,813		200,813	56,228	41,580	75,600				1,126,138	139,860	241,025
11	25,500	7.875	200,813		200,813	56,228	41,580	75,600				1,265,998	139,860	241,025
12	25,500	7.875	200,813		200,813	56,228		75,600	44,264			1,403,174	137,176	236,400
13	25,500	7.875	200,813		200,813	56,228		75,600	44,264	7,560		1,547,910	144,736	249,429
14	25,500	7.875	200,813		200,813	56,228		75,600	166,320	30,240		1,593,270	45,360	78,170
15	25,500	7.875	200,813		200,813	56,228			166,320	60,480		1,744,470	151,200	260,568
16	25,500	7.875	200,813		200,813	56,228			166,320	98,280	10,395	1,923,075	178,605	307,796

ANNEX 2a – Potential Carbon Emissions

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17	25,500	7.875	200,813		200,813	56,228			166,320	136,080	10,395	2,139,480	216,405	372,938
18	25,500	7.875	200,813		200,813	56,228			166,320	166,320	41,580	2,354,940	215,460	371,309
19	25,500	7.875	200,813		200,813	56,228				192,780	41,580	2,763,180	408,240	703,534
20	25,500	7.875	200,813		200,813	56,228				257,040	41,580	3,235,680	472,500	814,275
											Mid-term (4 years)			320,824
											Total 7 year project span:			1,012,958
											Total 20 year period:			5,576,155

5.2 Forest cover restored in forest reserves through MTS plantation and fire management:

Activity:

- 3.1 Structure MTS communities with clearly defined contractual and benefit sharing arrangements
- 3.2 Establish, maintain and monitor MTS Plantations
- 3.3: Fire management and control for plantation protection and for the restoration of savannah forests in the Reserves

Context and Basis of Carbon Impacts:

There are large areas of 'natural forest' that have been heavily degraded and in some cases deforested to grassland with the FRL reporting over 1.5m ha transitioning from forest to grassland during the 15 years from 2001-15³³. These areas, however, continue to have significant woody vegetation as well as young stems and have the potential for regeneration if widespread disturbance is halted³⁴. The most widespread disturbance that prevents regeneration of these areas is fire with late dry season fires being estimated to result in the loss of between 4.6 (in savannah woodland) and 10 (in grasslands) t d.m. per ha³⁵ – significantly higher than the growth rate of 2.4 t d.m. per ha for savannah forest areas³⁶. Implementation of early burning techniques in a mosaic across existing areas will help to reduce the number and spread of these mid and late dry season fires reducing both the area and impact of burning across the landscape (early season fires are noted to result in the loss of only 2.6 t d.m. per ha).

By engaging with MTS groups to provide training on early burning practices the project will work to ensure that MTS plantations are effectively protected from fire and that areas surrounding these plantations are also effectively protected (Activity 3.2. and Activity 3.3.).

While these will help to reduce deforestation and forest degradation they will be more critical in supporting forest regeneration of areas no longer classified as forest but that has the potential to return to forest if high impact land season fires can be removed from the system.

Baseline Data:

Target area: 26,000 ha of recently deforested areas with potential for natural regeneration surrounding MTS plantations.

Baseline carbon stock in grassland areas: ABG carbon stock of 12tCha⁻¹ ³⁷.

Growth rate of forest: African dry forest <20 years 2.4 tonnes dry matter per ha³⁸ = 1.128 tC per ha = 4.136 tCO₂e

Discount for early dry season burning – No discount is applied as research has indicated that early burning can actually have an overall positive impact on net growth rates³⁹.

³³ Ibid

³⁴ Information on condition of degraded and deforested reserve areas is provided in Forestry Commission & IUCN (2016) Validating criteria for savannah condition score assessment in Ghana

³⁵ Impact of early season dry season burns of savannah woodlands taken from Table 3A.13 Biomass consumption (t/ha) values for fires in a range of vegetation types of Annex 3A.1 of the IPCC Good Practice Guidelines (2003)

³⁶ Based on IPCC Good Practice Guidelines (2003) Table 4.9 Above ground net biomass growth in natural forests table 4.4

³⁷ GoG (2017) Draft Forest Reference Emission Level

³⁸ Based on IPCC Good Practice Guidelines (2003) - Table 4.9 Above ground net biomass growth in natural forests. Table 4.4 - Calculation steps for tier 1 – 4.36. Note that there are 0.47 tonnes Carbon per Tonne Dry Matter

³⁹ Information based on Burkina Faso Ministry of Environment, Green economy and Climate Change (2016) Literature Review on Impact of Fire on the Productivity of Forest Areas

Discount for ongoing impacts of other drivers of deforestation and forest degradation – the below provides estimates based on the main drivers of deforestation and forest degradation.

- *Logging* – No discount applied as it is assumed that as the areas are already deforested there is no merchantable timber available.
- *Fire* – It is assumed that the burning process will not be fully effective and that 10% of the area will be impacted by late dry season fires, which, will result in a loss of 4.6 t d.m. per ha
- *Wood fuel harvesting* – it is assumed that wood fuel harvesting will not occur as these are reserve areas and with increased community engagement and FC engagement they will be protected from illegal harvesting.

Impacts:

Table 9 Impacts of removals due to regeneration of forests protected by early burning

Year	Area (ha)	Total Existing C stock (tC)	Annual increase in ABG carbon stocks (tC)	Loss from late season burns (tC)	Total carbon stock at end of year (tC)	Net Carbon Increase (tC)	Net CO2 Sequestered (tCO ₂ e)
1							
2	4,000	48,000	4,512	406	52,106	4,106	15,054
3	8,000	100,106	9,024	813	108,317	8,211	30,107
4	13,000	156,317	14,664	1,321	169,660	13,343	48,924
5	18,000	217,660	20,304	1,829	236,135	18,475	67,741
6	22,000	284,135	24,816	2,236	306,715	22,580	82,795
7	26,000	354,715	29,328	2,642	381,401	26,686	97,849
8	26,000		29,328	2,642	410,729	26,686	97,849
9	26,000		29,328	2,642	440,057	26,686	97,849
10	26,000		29,328	2,642	469,385	26,686	97,849
11	26,000		29,328	2,642	498,713	26,686	97,849
12	26,000		29,328	2,642	528,041	26,686	97,849
13	26,000		29,328	2,642	557,369	26,686	97,849
14	26,000		29,328	2,642	586,697	26,686	97,849
15	26,000		29,328	2,642	616,025	26,686	97,849
16	26,000		29,328	2,642	645,353	26,686	97,849
17	26,000		29,328	2,642	674,681	26,686	97,849
18	26,000		29,328	2,642	704,009	26,686	97,849
19	26,000		29,328	2,642	733,337	26,686	97,849
20	26,000		29,328	2,642	762,665	26,686	97,849
					Mid-term (4 years)		94,085
					Total impact 7 years:		342,471
					Total impact 20 years:		1,614,505

6 Cross cutting Emission Reductions:

A number of cross cutting emission reductions have been identified that will result from the implementation of the project as a comprehensive package. These have not been allocated to specific activities or outputs as due to the complex interaction of drivers of forest cover change it is the combination of action across the outputs that will be central to delivering emissions reductions as opposed to a specific activity or output. This approach is in line with the Warsaw Framework on REDD+, which does not provide a methodology for nor requirement for the attribution of emissions reductions to specific activities.

6.1 Avoided Conversion of Forest to Agriculture:

Principal Activities:

All four outputs contribute to avoided conversion of forest to agriculture in CREMA

Output 1: Off reserve, degraded, savannah forests restored under self-financing community management in CREMA.

- Activity 1.1 Structure and empower communities for savannah forest management
- Activity 1.2. Develop sustainable forest management systems and adapt them to local conditions
- Activity 1.3 Enterprise and value chain development
- Activity 1.4 Restore forests through fire management in the Northern Savannah Zone
- Activity 1.5 Undertake enabling and support measures for community management of forests

Output 2: Degraded shea parklands restored through public private partnerships

- Activity 2.1 Restore and sustainably manage of shea parkland

Activity 2.2 strengthen value chains for shea processing

- Activity 2.3 Enhancing enabling environment for climate-smart shea and upscaling of finance and investments
- Output 3: Modified Taungya System plantations and fire management in forest reservesActivity 3.1 Structure MTS communities with clearly defined contractual and benefit sharing arrangements
- Activity 3.2 Establish, maintain and monitor MTS Plantations
 - Activity 3.3 promote Fire management and control for plantation protection and for the restoration of savannah forests in the reserves

Output 4: Integrated monitoring system implemented and REDD+ systems strengthened

- Activity 4.1 Address and respect safeguards
- Activity 4.2 Monitor, report and verifyof greenhouse gas emission reduction targets
- Activity 4.3 monitor and evaluate Project outputs

Context and Basis of Carbon Impacts:

The FRL reports forest conversion to cropland across the savannah zone as occurring at just under 34,000ha per annum or 1.34%. Much of this conversion is resulting from the removal of trees (in particular shea trees) within the agricultural landscape to make way for mechanised ploughing and expansion of agriculture due to population growth.

The project will implement a number of activities that will help to address these drivers:

Expansion of CREMA areas and strengthening of existing CREMAS (Output 1) – with limited forest areas remaining within the NSZ the project will target the establishment of CREMAS within these areas (Activity 1.1.). By strengthening their management, the project will support improved land use planning that will designate permanent forest areas and permanent agricultural areas (Activity 1.1.). This approach will be further strengthened by increasing the economic value of the forest for communities and community members, thus creating incentives to avoid conversion. (Activity 1.2. & 1.3.).

Strengthened interest and incentives for maintaining trees on farm (Outputs 1 and 2) – A strengthening of the rights of communities to trees on farm linked to both regulatory changes (Activity 1.5) and designation of CREMA areas (Activity 1.1.) will increase communities' willingness to invest in maintaining trees on farm. Similarly increases in awareness of their value (Activity 1.4. and 2.1.) and improvements in the value of shea trees (Activities 2.3) will help to incentivise individuals and families to maintain trees on farm.

Improved regional land use planning (Output 1) – Improved coordination between national, regional and local level governments as well as between sector agencies at the regional level with help reduce the expansion of commercialised agriculture in to more environmentally vulnerable areas especially river banks.

Reserve Management (Output 3 & 4) – through work on establishing MTS plantations (Activity 3.1. 3.2.) as well as conducting training on fire management around reserves (Activity 3.2) and increasing finance to FC staff responsible for reserve management (Activity 3.3.) the project will significantly strengthen the management of reserves within the NSZ. This will help to reduce the incidence of illegal activity in reserves, including encroachment and conversion to agriculture and illegal cutting of saw timber and wood fuels, both through improved monitoring by the FC and addressing and respecting the social and environmental standards (Activity 3.3. and output 4) and through community engagement linked to MTS development as well as reducing the incidence of high impact late dry season wildfires in reserves.

Baseline Data:

Forest areas were being converted to cropland at a rate of 12,500 ha per annum – the vast majority of this was conversion of open forest to cropland (12,333 ha per annum)⁴⁰.

Emissions factor for open forest to cropland is 156.9 tCO₂e per ha⁴¹.

Impacts:

The impacts of these interventions are anticipated to be significant in areas targeted by the project. The highly fragmented nature of remaining forest cover, however, means that it will be impossible for the project to deliver comprehensive protection across such a wide area. Due to these challenges the project targets a conservative 15% reduction in emissions per annum based on the project achieving almost 100% impact within CREMA areas but a lower level of impact across the full landscape. It also focuses on conversion of open forest to crop land with it assumed that much of the remaining closed forest is already within key protected areas such as Mole National Park. This level of impact will be achieved over time as project activities are increased and more comprehensively implemented.

Table 10 Impacts of reduced conversion of forest to cropland

Year	Business as Usual Level of Deforestation (ha)	Percentage reduction in deforestation	Area of avoided deforestation	Emission factor Open forest to cropland	Total reduction in emissions
1	12,333	0%	-	156.9	-
2	12,333	5%	617	156.9	96,752
3	12,333	5%	617	156.9	96,752
4	12,333	10%	1,233	156.9	193,505
5	12,333	10%	1,233	156.9	193,505
6	12,333	15%	1,850	156.9	290,257
7	12,333	15%	1,850	156.9	290,257
8	12,333	15%	1,850	156.9	290,257
9	12,333	15%	1,850	156.9	290,257

⁴⁰ Specific assessment of land use change within the NSZ undertaken November 2017 (Winrock, Ghana FC – unpublished)

⁴¹ GoG (2017) Forest Reference Level submitted to UNFCCC October 2017

10	12,333	15%	1,850	156.9	290,257
11	12,333	15%	1,850	156.9	290,257
12	12,333	15%	1,850	156.9	290,257
13	12,333	15%	1,850	156.9	290,257
14	12,333	15%	1,850	156.9	290,257
15	12,333	15%	1,850	156.9	290,257
16	12,333	15%	1,850	156.9	290,257
17	12,333	15%	1,850	156.9	290,257
18	12,333	15%	1,850	156.9	290,257
19	12,333	15%	1,850	156.9	290,257
20	12,333	15%	1,850	156.9	290,257
				Mid-term	387,010
				Total 7 years	1,161,029
				Total 20 years	4,934,372

6.2 Reduced Conversion of Forest to Grassland:

Principle Activities:

Output 1: Off reserve, degraded, savannah forests restored under self-financing community management in CREMA

- Activity 1.1 Structure and empower communities for savannah forest management
- Activity 1.2. Develop sustainable forest management systems and adapt them to local conditions
- Activity 1.3 Enterprise and value chain development
- Activity 1.4 Restore forests through fire management in the Northern Savannah Zone
- Activity 1.5 Undertake enabling and support measures for community management of forests

Output 2: Degraded shea parklands restored through public private partnerships

- Activity 2.1 Restore and sustainably manage shea parkland
- Activity 2.2 strengthen value chains for shea processing
- Activity 2.3 Enhancing enabling environment for climate-smart shea and upscaling of finance and investments

Output 3: Modified Taungya System plantations and fire management in forest reserves

Activity 3.1 Structure MTS communities with clearly defined contractual and benefit sharing arrangements

- Activity 3.2 Establish, maintain and monitor MTS Plantations
- Activity 3.3 promote fire management and control for plantation protection and for the restoration of savannah forests in the reserves

Output 4: Integrated monitoring system implemented and REDD+ systems strengthened

- Activity 4.1 Address and respect safeguards
- Activity 4.2 Monitor, report and verify of greenhouse gas emission reduction targets
- Activity 4.3 monitor and evaluate Project outputs

Context and Basis of Carbon Impacts:

The FRL reports forest conversion to grassland across the savannah zone as occurring at just over 100,000ha per annum. Much of this conversion is resulting from the unsustainable harvesting of wood fuels and harvesting of rosewood. The impacts of these drivers are then exacerbated by the impacts of late dry season fires that prevent regeneration and cause further degradation to the point that forests are unable to regenerate and in many cases continue to degrade to the point of deforestation.

The project will implement a number of activities that will help to address these drivers:

Expansion of CREMA areas and strengthening of existing CREMAs (Output 1) – with limited forest areas remaining within the NSZ the project will target the establishment of CREMAs within these areas (Activity 1.1.). By strengthening their management (Activity 1.1. & 1.5.) the project will strengthen the protection of remaining forest areas from the impacts of logging and charcoal production. The role of CREMAs will be further strengthened by legislative changes that increase the strength of CREMA legal protection (Activity 1.5.) as well as development of sustainable wood fuel production systems (Activity 1.2. & 1.3.) that will take pressure off the remaining forest areas and provide increased revenue into communities helping to reduce the incentives of other destructive activities.

Improved awareness of and capacity for fire management (Outputs 1 and 3) – The project will increase awareness of and capacity for fire management through early burning (Activity 1.2., 1.3., & 3.2.). As a result of this there will be a reduction in more destructive late dry season fires. This will help increase the capacity of forest areas to regenerate and prevent forest degradation resulting in deforestation.

Reserve Management (Output 1, 3, 4)– through work on establishing MTS plantations (Activity 3.1. & 3.2.) as well as conducting training on fire management around reserves (Activity 3.2.) increasing finance to FC staff responsible for reserve management (3.3.) and improving monitoring systems (Activity 4.2.) the project will significantly strengthen the management of reserves within the NSZ. This will help to reduce the incidence of illegal activity in reserves, both through improved monitoring by the FC and through community engagement linked to MTS development as well as reducing the incidence of high impact late dry season wildfires in reserves.

Baseline Data:

Forest areas were being converted to cropland at a rate of just over 57,000ha per annum – the vast majority of this was conversion of open forest to cropland (55,755ha per annum)⁴².

Emissions factor for open forest to cropland is 26.25 tCO₂e per ha⁴³.

Impacts:

The impacts of these interventions are anticipated to be significant in areas targeted by the project. The highly fragmented nature of remaining forest cover however means that it will be impossible for the project to deliver comprehensive protection across such a wide area. Due to these challenges the project targets a conservative 15% reduction in emissions per annum based on the project achieving almost 100% impact within CREMA areas but a lower level of impact across the full landscape. It also focuses on conversion of open forest to crop land with it assumed that much of the remaining closed forest is already within key protected areas such as Mole National Park. This level of impact will be achieved over time as project activities are increased and more comprehensively implemented.

⁴² Specific assessment of land use change within the NSZ undertaken November 2017 (Winrock, Ghana FC – unpublished)

⁴³ GoG (2017) Forest Reference Level submitted to UNFCCC October 2017

Table 11 Impacts of reduced conversion of forest to grassland

Year	Business as Usual Level of Deforestation (ha)	Percentage reduction in deforestation	Area of avoided deforestation	Emission factor Open forest to grassland	Total reduction in emissions
1	55,755	0%	-	26.3	-
2	55,755	5%	2,788	26.3	73,318
3	55,755	5%	2,788	26.3	73,318
4	55,755	10%	5,576	26.3	146,636
5	55,755	10%	5,576	26.3	146,636
6	55,755	15%	8,363	26.3	219,935
7	55,755	15%	8,363	26.3	219,935
8	55,755	15%	8,363	26.3	219,935
9	55,755	15%	8,363	26.3	219,935
10	55,755	15%	8,363	26.3	219,935
11	55,755	15%	8,363	26.3	219,935
12	55,755	15%	8,363	26.3	219,935
13	55,755	15%	8,363	26.3	219,935
14	55,755	15%	8,363	26.3	219,935
15	55,755	15%	8,363	26.3	219,935
16	55,755	15%	8,363	26.3	219,935
17	55,755	15%	8,363	26.3	219,935
18	55,755	15%	8,363	26.3	219,935
19	55,755	15%	8,363	26.3	219,935
20	55,755	15%	8,363	26.3	219,935
Mid-term (4 years):					293,271
Total reduction in emissions 7 years:					879,814
Total reduction in emissions 20 years:					3,739,209

6.3 Reduced Degradation:

It is estimated that emission reductions due to reduced forest degradation will total 341,656tCO₂e over the lifetime of the project and 1,452,038 tCO₂e over a 20 year period:

- *Wood fuels harvesting* – Reductions in levels of harvesting for shea production are addressed specifically under Output 2. The project will also work to increase the efficiency of charcoal production (Activity 1.3.) thus reducing the level of impact a unit of charcoal has on forest areas. In increasing efficiency and sustainability of production the project will thus also lay critical ground work towards the proposed transition to a sustainable charcoal production system in Ghana. The improved approaches developed by the project will be scaled up over time with increased regulation helping to reduce levels of unsustainable harvesting. This transition however will take time, with the draft NAMA for Sustainable Charcoal Production having a time line of 20 years, and as such it is not anticipated that significant changes will occur in the projects lifetime.
- *Timber harvesting* – the harvesting of Rosewood has been widely reported as having a significant impact on the forests of the NSZ. Information on this is, however, not specifically reported in the FRL. Proxy

measures developed in the background assessment using the information from the FRL and timber exports of Rosewood, identified emissions from these activities at between 15,000 and 360,000 tCO₂ per annum with average emissions of 134,667 tCO₂ per annum over a 7 year period from 2011-17 (the period in which Rosewood harvesting has become prevalent) and using an emission factor of 0.81tCO₂e per m³ ⁴⁴ to convert from reported m³ exported and levels of emissions⁴⁵. The project will help to reduce levels of Rosewood and other illegal timber harvesting through the establishment and strengthening of the CREMA network (Activity 1.1. & 1.5) which will help to reduce harvesting within CREMA forest areas. It will also strengthen the management for forest reserves (Activity 3.3.) that will help to reduce levels of illegal activity within them. Based on these activities the project will help to deliver emission reductions of **80,800 tCO₂e** across the 7-year project lifetime and **343,400 tCO₂e** over the 20 year timeframe with it estimated that no impact will occur in the 1st year of the project, years 2-3 will see 5% impact, years 4-5 will see a 10% impact with a 15% impact being seen from year 6 onwards.

- *Fire* – The impacts of fire management on grassland areas are addressed within Outputs 1 and 3. The activities (Activities 1.4. and 3.2.) noted within these areas will also have an impact on forest areas with improved fire management helping to reduce degradation due to fire. These impacts, which, result in deforestation are noted under cross cutting impacts Reduced Conversion of Forest land to grassland. The FRL however also focuses on fires that do not result in deforestation but only forest degradation with fires of this nature resulting in average annual emissions of 434,760tCO₂e from the savannah region. It is anticipated that through work on fire management within reserves (Activity 3.2.), in CREMAs (Activity 1.2.) and across the zone through awareness raising (Activity 1.4.) it is anticipated that the impacts of fire on forests areas will reduce by 10% resulting in emission reductions of **260,856 tCO₂e** across the 7 year project lifetime and **1,108,638 tCO₂e** over the 20 year timeframe with it estimated that no impact will occur in the 1st year of the project, years 2-3 will see 5% impact, years 4-5 will see a 10% impact with a 15% impact being seen from year 6 onwards.

⁴⁴ Emissions factor reported in GoG (2017) Draft Forest Reference Level submitted to the UNFCCC in October 2017 based on field work carried out by the FC – it is recognized that this emission factor may not be fully representative of the impacts of such harvesting within the savannah forest as opposed to moist tropical forest in which most FC assessment were conducted.