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Global Shea Alliance

SHEA VALUE CHAIN

AS A KEY PRO-POOR CARBON-FIXING ENGINE IN WEST AFRICA

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SHEA VALUE CHAIN

AS A KEY PRO-POOR CARBON FIXING ENGINE IN WEST AFRICA

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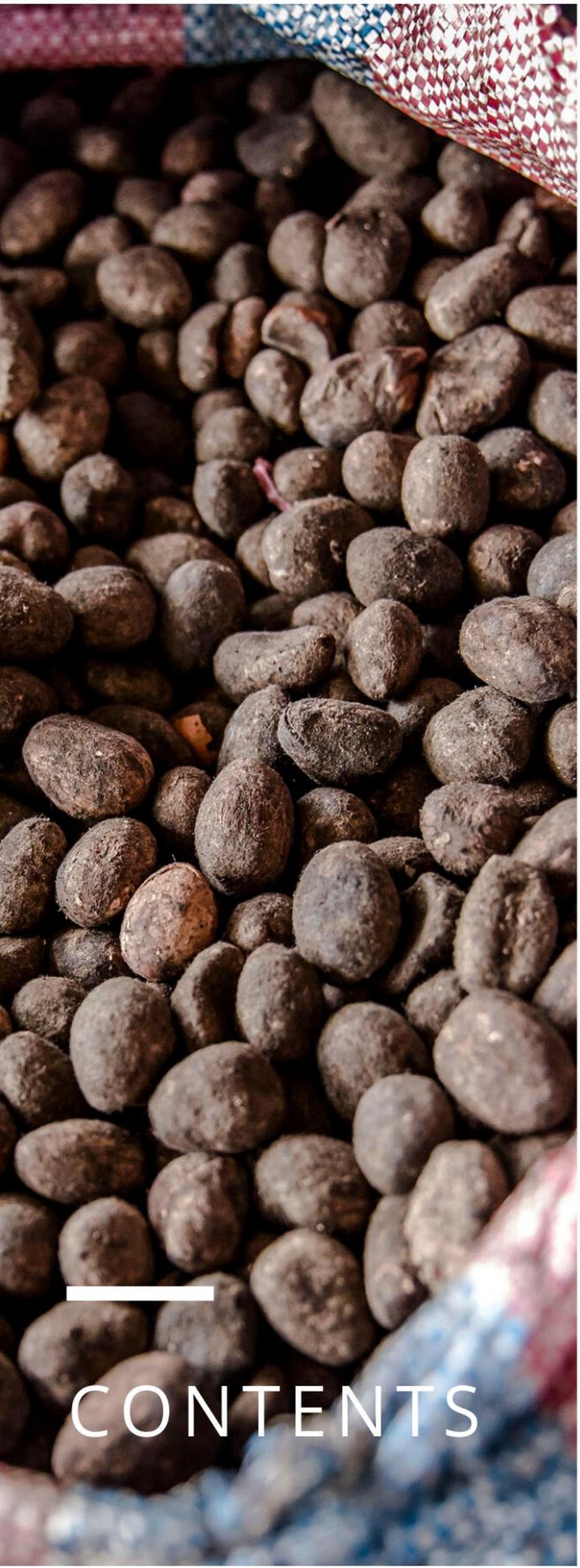

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EXECUTIVE SUMMARY

As part of its Sustainability Program, the Global Shea Alliance (GSA), in partnership with the Food and Agriculture Organization of the United Nations (FAO Regional Office for Africa), is conducting a multi-impact appraisal of the shea value chain in 8 West African countries that account for 99 percent of shea exports.

The study uses the Ex-ante Carbon-balance Value Chain tool (EX-ACT VC), developed in 2016 by FAO, to assess the value chain's contribution to climate mitigation, climate resilience, and socio-economic impact. The tool makes an assessment for 2018 as well as under a defined growth scenario in 2032, in line with the sustainable land management investments mobilized through Great Green Wall all over the West Africa Sahel (over USD 3 billion before 2030) and other initiatives.

Preliminary assessment results found that shea has an enormous potential to mitigate climate change in West Africa. At present, the shea value chain fixes 1.5 million tonnes of CO_2 every year. Relative to production volumes, every ton of shea kernels produced has a negative carbon footprint of 1.04 tonnes of CO_2. With an expansion strategy supported by donors and private partners to increase shea tree population in agroforestry areas by 7 million additional trees per year, the CO_2 fixed could increase up to 9 million tonnes of CO_2e per year, leading to an aggregated carbon fixing impact of 180 million tonnes of CO_2e over 20 years. This translates to a carbon footprint of - 8 tonnes CO_2e for every ton of shea kernel produced. This positive environmental impact of the value chain stems from its production system: shea trees grow naturally and are integrated with crops on smallholder farms, creating an agroforestry landscape that acts like a carbon sink. Expansion of agroforestry areas acts as a multiplying factor.

This strategy will increase the climate resilience of the value chain beneficiaries, who are living in a climate change hotspot. According to the scientific findings of the Intergovernmental Panel on Climate Change (IPCC), temperatures over West Africa are projected to rise by 3 °C to 6 °C by 2100, with unprecedented climate conditions occurring by the 2040s (IPCC, 2014).

The shea value chain is also important in terms of income creation for women in rural areas. In 2018, every day of work generates USD 1.9 of value added for women. Overall in the region, the value chain has a gross production value of about USD 284 million and a value added of USD 203 million, which is mostly captured at local production level by women collectors and local processors. The gross income per woman collector is at USD 75 annually.

Through shea parklands expansion and improvement of collector productivity, the gross income per woman collector could increase to USD 167/ year, while the value added per day of work will reach USD 2.30. The global value chain will reach a gross production value of about USD 593 million, representing 6 percent growth per year between 2019 and 2032 and a value added of USD 452 million by 2032.

The public investment needs for upscaling the value chain are estimated to be around USD 153 million. On this basis, the shea value chain provides an efficient carbon fixing mechanism with a cost of USD 0.85 per ton of CO_2 fixed. The economic value of such a positive externality could be around USD 270 million per year, making the value chain a high mitigation return on investment.

The global economic analysis of the economic and environmental benefits of the regional value chain results in a net present value for the growth scenario of USD 1.9 billion after investment, and an internal rate of return of over 100 percent when accounting for both public and private investments.

Such performances confirm the relevance of regional shea value chain as key Pro-Poor Carbon-Fixing Engine in West Africa. By linking it with other regional value chains, such as cashew and gum, shea could be part of a regional agroforestry scaling up initiative in line with the Africa Climate Business Plan (ACBP) and the vision of accelerated transformation in the Malabo Declaration.

1 INTRODUCTION

The Global Shea Alliance (GSA) is a non-profit industry association with 500 members from 35 countries including women's groups, brands and retailers, suppliers, and non-profits, headquartered in Accra, Ghana. Established in 2011, the GSA promotes industry sustainability, quality practices and standards, and demand for shea in food and cosmetics through a public-private partnership model.

In partnership with the Food and Agriculture Organisation of the United Nations (FAO) Regional Office for Africa, the GSA has decided to undertake a regional West Africa value chain study for shea. Assessing the current regional impact of the shea value chain and designing a series of value chain rehabilitation-expansion scenarios to be appraised in terms of co-benefits, is key to driving public and private investment in the sector, including through joined policy and climate-funds that will support the transformation of the shea value chain to a landscape management, carbon fixing, pro-poor engine.

Specific objectives of the study are:

- Capture data on shea tree areas, number of value chain actors, volume collected and processed, marketing channels and prices for the 8 countries targeted (Guinea-Conakry, Mali, Ghana, Nigeria, Benin, Ivory Coast, Burkina Faso and Togo),
- Assess potential improvements in term of expansion of shea trees through parklands, improved processing with reduced wood consumption, resilience-building options, and improved post-harvest stock-marketing options,
- Review and upgrade scenarios with GSA members,
- Develop a series of country-based VC models using EX-ACT VC tool,
- Assess sustainability impact of such VC growth options (social, economic, environment) with detailed GHG impact (GHG mitigation impact per year, carbon balance on 20 years, carbon footprint per ton of shea, carbon fixed per USD of invested),
- Estimate cost of implementation of such scenarios (public and private cost),
- Assess potential public-private partnership opportunities with GSA, and
- Organize policy restitution workshops with country institutions, national policy makers and donors.

The study will first provide some background information on shea and agroforestry systems, lay out the data used, outline the current social, economic, and environmental impact of the value chain, define the targets for an upgraded scenario, and outline its impact and the related investment needed to implement the scenario.

2 BACKGROUND

2.1 Agroforestry parklands

Agroforestry parklands consist of farmland areas with scattered multipurpose trees as a result of farmer selection, protection and management. They include long-term cultivation and fallow components. Although frequently dominated by just one or a few species, parklands can include a large number of woody species. For example, Burkina Faso has on average 8-10 woody species per hectare. Agroforestry parklands are the dominant farming system in semi-arid West Africa and in Sahelian countries (Boffa, 1999) (Nikiema, 2005).

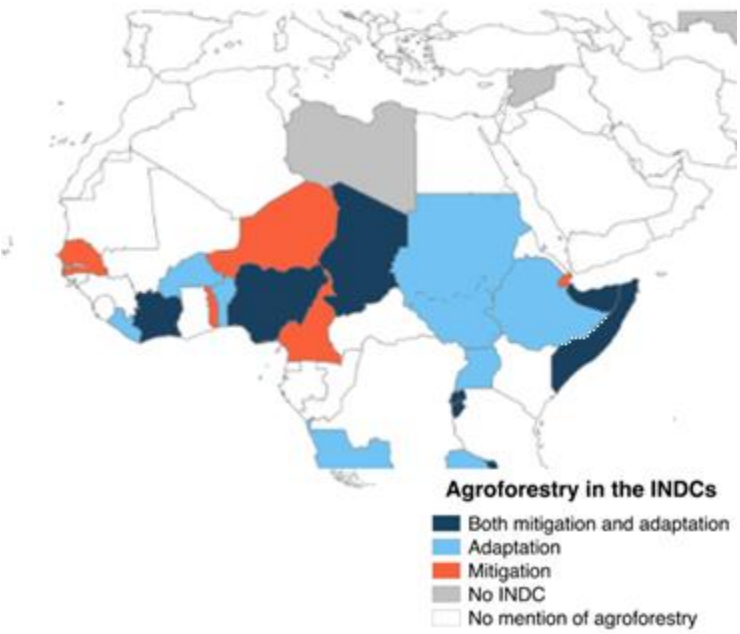
Non-Wood Forest Products (NWFP) production in agroforestry parklands generates significant income for a variety of local economic actors. A wide range of parkland products are intensively commercialized. Although a coordinated evaluation of the importance of individual commodity markets has not been carried out, available figures point to income-earning opportunities which are significant for individual households, communities and local economies. It represents up to 25 percent or more of the total income of non-specialized individual producers. NWFP include internationally traded products such as gum arabic and shea kernels.

Parkland and NWFP production play a fundamental role in ensuring social equality and cultural stability. Vulnerable social groups including women, the poor, immigrants and young adults, are particularly involved in the gathering and sometimes the processing of parkland products because these activities require no cash investment. Product marketing is also predominantly done by women. Parkland products tend to represent a higher proportion of women's than men's income, and impact women's economic level and children’s nutritional status. Production and commercialization activities of parkland products promote interactions between gender, age and ethnic groups and encourage transfer of indigenous technical knowledge, economic exchanges and social integration (Boffa, 1999).

2.2 Agroforestry role in climate change adaptation and mitigation

As illustrated *Figure 1*, agroforestry is a key topic in the Intended Nationally Determined Contributions (INDCs) of most shea-producing countries, whether for mitigation, adaptation, or both (CGIAR-CCAFS, 2017). With food shortages and increased climate change threats, interest in agroforestry is increasing due to its potential to address various on-farm adaptation needs, and fulfil many roles in Agriculture, Forestry and Other Land Uses (AFOLU) related mitigation pathways. Agroforestry provides assets and income from carbon, wood energy, improved soil fertility and enhancement of local climate conditions; it provides ecosystem services and reduces human impacts on natural forests (Mbow, Smith, Skole, Duguma, & Bustamante, 2014).

Figure 1: Countries mentioning agroforestry as a priority in their INDCs

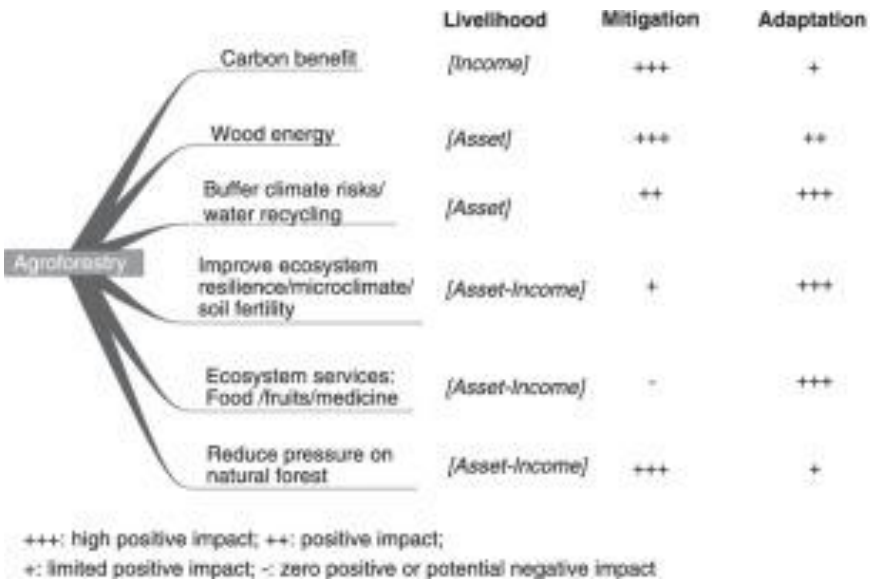


Source: CCAFS, 2017
Conforms to the UN World map, February 2019

Agroforestry systems in Africa constitute the third largest carbon sink after primary forests and long-term fallows. In Africa, 1 550 million ha are suitable for some type of agroforestry (Unruh, Houghton, & Lefebvre, 1993).

Agriculture and agroforestry are part of the solution to slowing forest degradation and to enhancing tree cover in agricultural and degraded landscapes. Policy makers, donors, private sector, and other stakeholders urgently need additional analysis, evidence-based and cost-effective solutions to guide investments towards restoration of tree cover in deforested yet valuable landscapes such as shea parklands, with the goal of maximizing the prospects for development and poverty reduction in the Sahel region (LEAVES & PROFOR, 2018).

Figure 2: Impacts of implementing agroforestry

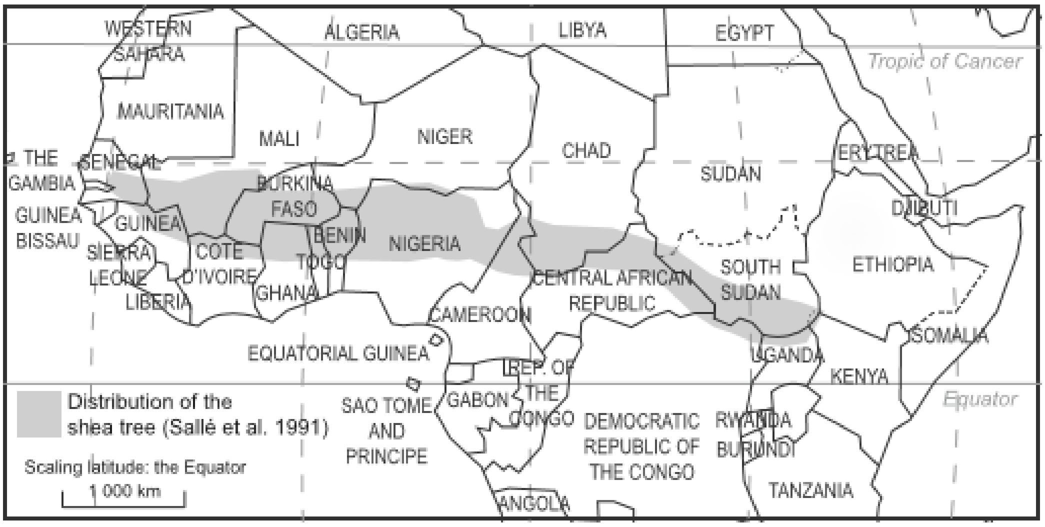


2.3 Shea parklands

Shea trees (*Vitellaria paradoxa*) grow in parklands, dry savannahs and forests on a strip of about 5,000 km across Africa (IPGRI, 2006), more precisely in Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Côte d'Ivoire, Democratic Republic of Congo, Ethiopia, Gambia, Ghana, Guinea-Bissau, Guinea-Conakry, Mali, Niger, Nigeria, Senegal, Sierra Leone, South Sudan, Sudan, Togo and Uganda. Like most agroforestry parkland trees, shea trees are managed by farmers in their agricultural lands where they are grown in association with annual crops and are protected from bush fire and uncontrolled competition for nutrients. Shea trees represent up to one third of parkland trees in areas where the average tree density is around 40 trees per ha (Nikiema A. , 2005).

The flesh of the shea fruit is widely consumed by local people, sold in the local and urban markets in West Africa, and is also used for animal fodder. The kernel is the most economically valuable product of the shea tree, as it contains 31-62 percent edible fat) (Nikiema, Umali, & B.E., 2007).

Figure 3: Map of shea tree distribution across Africa



Conforms to the UN World map, February 2019

Shea trees are usually not planted but selected, saved, and protected by farmers in their fields (Rousseau & Gautier, 2015). They are well adapted to poor shallow soils and dry environments and have a life span of between 200 and 300 years (Boffa, 2015). Shea trees start fruiting at about 15 years old and reach full production by 45 years (Höfer, 2009). A mature tree can bear on average 15–30 kg fruits per year (3-6 kg of kernel) and up to 50 kg during very good harvest years (Nikiema, Umali, & B.E., 2007). Shea fruits are collected and processed by women between May and August (Boffa, 2015).

All aspects of the shea tree have tangible and intangible value. Obtaining shea butter from shea kernels is a labour-intensive process. The butter is used locally for cooking, as well as for cosmetic and cultural uses (Boffa, 2015).

Shea kernels and shea butter trade have assumed global proportions over the last two decades. The food industry (confectionary and bakery sectors) uses approximately 90 percent of the international supply, while the rest is absorbed by the cosmetic industry (LMC, 2017). Producers harvest only a fraction, about 50 percent (~ 820 000 mt), which is then transformed into butter or exported as kernels (LMC, 2017).

Shea production is cyclical – with one bad harvest following two good harvests. When local production is weak, domestic markets respond with rising prices of raw shea kernels and inflation, propagating all along the value chain up to internationally traded shea-based commodities. Considering the market is expanding for shea (+600 percent in the last 20 years, with a 50 percent increase forecasted for the next 5 years), unstable production is a concern for the industry.

3 METHODOLOGY

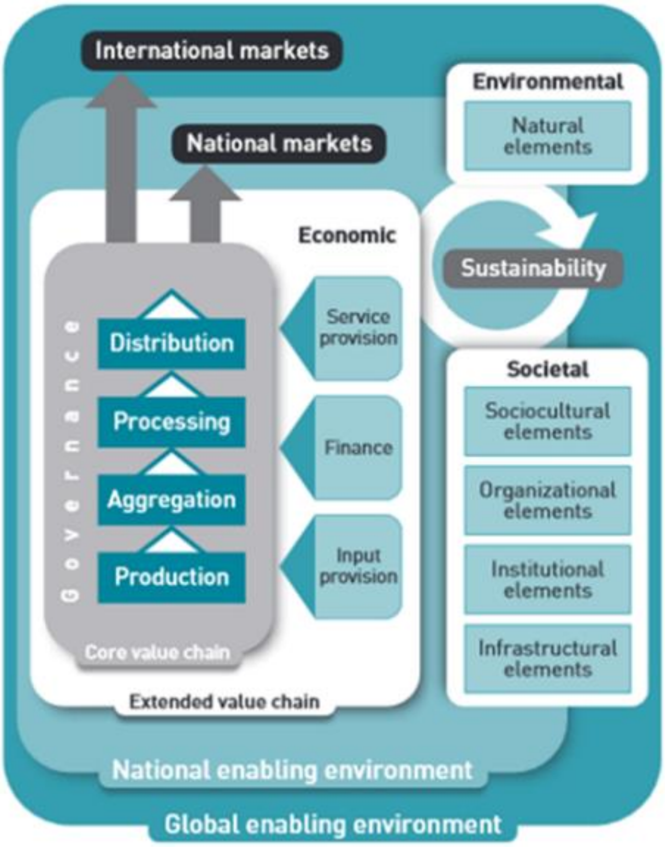
3.1 Definitions

3.1.1 *Sustainable Food Value Chain Framework*

A sustainable food value chain is defined as the full range of farms, micro-agents, firms and their successive coordinated value-adding activities that produce and transform raw agricultural materials into food products that are sold to final consumers and disposed of after use – all in a manner that is profitable throughout, has broad-based benefits for society, and does not permanently deplete natural resources.

Unlike the related concepts of “filière”, “commodity chain” and “supply chain”, the sustainable food value chain concept stresses the importance of three elements: (i) a “value chain” is a broadly defined concept and may be applied to any product subsectors (e.g. beef, maize, cocoa or shea), (ii) value chains are dynamic, market-driven systems governed and regulated through vertical coordination; and (iii) sustainability and the value added are explicit and multidimensional performance measures are assessed at an aggregate level (FAO, 2014).

Figure 4: The sustainable food value chain framework



The climate-smart agriculture (CSA) concept, launched by FAO in 2010, encompasses agriculture that targets food security and development goals through sustainable practices (FAO, 2013). CSA has three main objectives: (i) to increase food security while boosting productivity and income generation; (ii) to enhance the resilience of agricultural systems and rural populations to climate change; and (iii) to reduce GHG emissions in agriculture (mitigation). Thus, CSA is neither a new agricultural model, nor a new set of practices, but rather a framework for developing more productive and sustainable food value chains. This framework involves (i) climate change mitigation and adaptation options through ecosystem management in order to (ii) preserve existing carbon stocks and decrease existing carbon sources, and (iii) improve smallholder livelihoods to reduce their vulnerability to climate change.

The sustainable food value chain framework acts as a guidance for structuring the analysis of the food chain performance. This framework involves the value chain actors, i.e. those who produce a good or a service, who add value to the product, sell it, transfer it to the next level or export it. In this framework, shown in Figure 4, four core functions of the value chain are identified: (i) production (agriculture, livestock, and fishing), (ii) aggregation, (iii) processing and (iv) distribution (wholesale and retail) at local, national and international levels (FAO, 2014).

This framework enables to identify criteria that can serve as growth engines, to assess the poverty reduction potential of an activity, and to facilitate the adoption of agricultural strategies with appropriate policy measures.

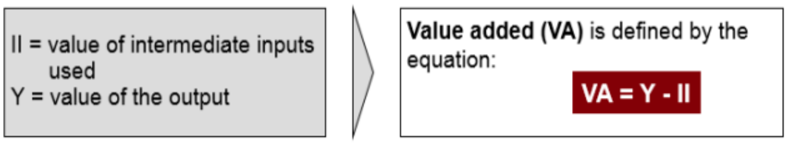
3.1.2 *Value Chain Analysis (VCA)*

One of the most critical concepts in value chain analysis (VCA) is the "value added" in the entire production process. The "value added" (VA) measures the accumulation of wealth and the contribution of the production process to economic growth, and is one of the key concepts identified by Porter (Porter, 1985) and FAO (FAO, 2014).

It is defined as the difference between the gross production value (incorporating the value of all factors that contribute to production) and the wealth consumed in the production process (Bockel & Tallec, 2005). In other words, the VA is the value that each agent, at each stage of the value chain, adds to the value of inputs during the accounting period of the food production process. The VA generated during the production process, from producers to retailers, plays a major role in the performance of food value chains as it directly impacts poverty and hunger.

VA can be calculated for each intermediate agri-food product and at every stage of the value chain (i.e. storage, conditioning, transport, processing, etc.). It can also increase or decrease over space and time (FAO, 2014). Calculating the VA enables to analyse the redistribution of wealth generated at each level of the chain.

Figure 5: The concept of value added



The VA is calculated as the difference between the intermediate inputs used (II) and the value of the output in the post-production phase (Y). VA has five major components: (i) the salaries of workers, (ii) tax revenues to the government, (iii) returns to assets (profits), (iv) a better food supply to consumers (consumer surplus) and (v) environmental impact (FAO, 2014). Redistribution is thus measured amongst different economic agents: households (returns of labour), financial institutions (interest charges), government (taxes), and non-financial enterprises (gross income).

The impact of upgrading a value chain can be analysed at a socio-economic level by assessing the increase or decrease of the VA at every stage of the production process. An increase in the VA implies an increase in the ability of its components to better target poverty reduction and food security.

3.1.3 *Life Cycle Analysis (LCA)*

Life Cycle Assessment (LCA) is an internationally recognized approach that evaluates the relative potential environmental impacts of products and services throughout their life cycle, beginning with raw material extraction and including all aspects of transportation, production, use, and end-of-life treatment. LCA is a quantitative technique for assessing the potential environmental aspects and potential aspects associated with a product (or service), by: (i) compiling an inventory of relevant inputs and outputs, (ii) evaluating the potential environmental impacts associated with those inputs and outputs, and (iii) interpreting the results of the inventory and impact phases in relation to the objectives of the study ISO (2006a). LCA is used to identify opportunities to improve the environmental performance of products, inform decision-making, and support marketing, communication and awareness-building efforts.

The LCA based carbon footprint of a product is the quantity of greenhouse gases (GHG), expressed in carbon dioxide equivalent (CO_2e), emitted across the supply chain for a single unit of that product. Each step of the value chain is taken into account as shown in figure 4 – from the production of raw materials, transportation and transformation, to the final use and the disposal of the waste generated. The carbon footprint is one of a series of environmental impact indicators included in the LCA (Lescot, 2012). Product carbon footprinting (PCF) is commonly used to calculate the GHG emissions released from food supply chains as in the EX-ACT VC tool.

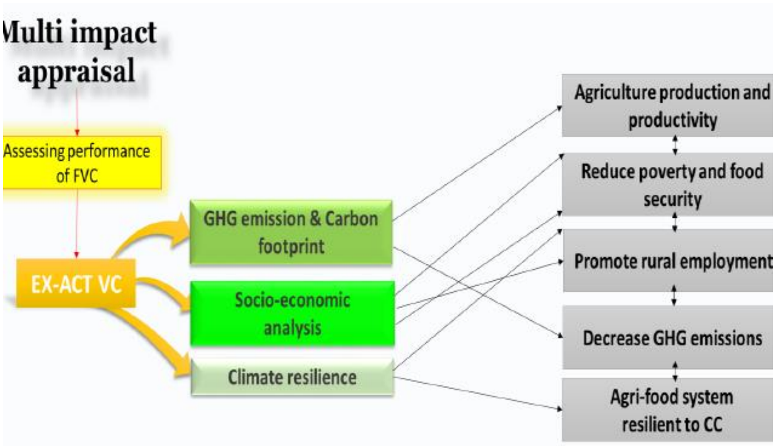
A social and socio-economic Life Cycle Assessment (S-LCA) is a social impact (and potential impact) assessment technique that aims to assess the social and socio-economic aspects of products and their potential positive and negative impacts along their life cycle production, processing, transport, distribution, use, recycling and/or final disposal (UNEP, 2009).

3.2 Methodology used: FAO Ex-ante Carbon-balance Value Chain (EX-ACT VC) tool

The EX-ACT VC tool, developed in 2016, covers value chains for crops, livestock, fisheries, and aquaculture. EX-ACT VC methodology provides both a quantified socio-economic appraisal (at both the micro- and at the meso-levels (i.e. by agent, by stage and by sector)), and an environmental carbon-balance appraisal (climate mitigation, adaptation and resilience).

Designed for multi-impact appraisal, the tool provides performance assessments for value chains in the following areas: (i) climate mitigation (GHG emissions, carbon footprint, economic return of climate mitigation), (ii) climate resilience (iii) socio-economic performances (value added, income and employment generated) and other environmental factors (such as water use and energy use). These can be applied for either the current chain scenario, or for assessing an upgraded scenario.

Figure 6: Output of EX-ACT VC tool



To elaborate, within EX-ACT VC:

- The impacts in terms of climate mitigation are assessed through quantitative indicators – to measure both the current scenario and growth scenario in terms of tonnes of CO_2-equivalent (tCO_2-e). The carbon footprint, based on LCA, is calculated for the whole value chain and each of the different analytical stages. This comprehensively evaluates the environmental performance of the chain. The equivalent economic return is also determined, as this may be important when considering, for example, access to environmental services.
- The socio-economic performance of the value chain is evaluated in terms of value added, income and jobs generated throughout the chain.
- Value chain resilience is estimated using quantitative and qualitative indicators, measuring the reduction in the vulnerability to climate change of people, livelihoods, ecosystems and value chains (Ifejika Speranza, 2010).

3.3 Data collection methods

Data for this analysis was gathered through literature review and interviews with the GSA members for information on labour, cost and inputs used by women for collecting and processing, prices with intermediary collectors, and means of transport and average distance from first collection to downstream aggregation stakeholders. Questionnaires and checklists for surveying of stakeholder panels were prepared for women collectors, village intermediaries, regional-downstream intermediaries, processing units.

Preliminary results and hypothesis were discussed at the GSA Sustainability Working Group in November 2018, International Shea Conference in March 2019, EU Conference in April 2019, as well as through individual consultations with stakeholders.

4 DATA USED

4.1 Women shea collectors

16 million women—half of them in West Africa—are involved in shea related activities. 4 000 000 women are involved in the export value chain with USD 200 million generated as income every year in producing communities (LMC, 2017).

Consequently, there are two categories of women collectors, (i) women collectors acting as value chain agents collecting shea fruits and selling both kernels and butter (about 4 000 000) and (ii) micro harvesting consumer women who collect very small quantities for their home consumption (about 4 000 000).

4.2 Macro level data

According to the Naughton, Lovett and Mihelcic's (2015) land suitability model of shea distribution and production[1], there are 1.84 billion trees on an extensive shea tree area of 3.41 million km^2.

For West Africa, the model provides an estimate of high stearin trees of 1.07 billion trees (lower tree density assumption). This will serve as the basic macro data in the present study. The model does also provide a potential for the production of 1.63 million tonnes shea kernels and of 0.54 million of shea butter (lower density option).

According to the GSA, the total geographic area covered by shea trees in the West African region is estimated to be 1.7 million km^2, corresponding to a tree density figure of 6.3 trees ha^{-1}.

Table 1 : Details on shea tree coverage in West African countries

8 Countries covered		Benin, Burkina Faso,Ivory Coast, Ghana, Guinea Conakry, Mali, Nigeria, Togo				
(geospatial model; based)	total area	1 700 000	km2	density		
Total of shea trees in West Africa		1 070 000 000	trees	6.3	trees /ha	
Total Area with shea trees		499 220	km^2	21.4	trees /ha	

Source: screen print of FAO EX-ACT VC based shea model 2018

Shea tree inclusive land systems, characterized by a density of 6 to 50 trees per hectare, cover 50 million ha (499 220 km^2), including agroforestry cropped areas, set aside land, shrubland forest, and improved parklands.

4.3 Landscape data

Shea tree populations have been under pressure from the following factors (ranked in order of their assumed magnitude): (i) extension of cultivation periods, decreasing length and frequency or disuse of fallow periods, which are required for the traditional regeneration of shea populations; (ii) large-scale land investment and agricultural development projects for high intensity, mechanized food and biofuel crop production removing shea trees in fields, (iii) uncontrolled tree cutting for firewood and charcoal production, and (iv) past droughts which have shifted the species distribution southward (Boffa, 2015). All these aspects are reflected within the low assumptions used for production per tree and trees per hectare (Tables 2 and 3 below).

Based on past research (Poudyal, 2011), the GSA also provided a series of average densities per ha of shea trees per type of landscape. Yields per tree were derived from the Naughton article (Naughton, Lovet, Mihelcic, & J., 2015) and reviewed against GSA data.

[1] It uses the Global Land Cover 2000 map of Africa (GLC2000) on World Geodetic System (WGS) and takes into account two known sub-species Vitellaria paradoxa ssp. paradoxa predominant in West Africa and ssp. nilotica found in Central and East Africa – the former typically having high stearin and the latter having low stearin.

Table 2: Data used on forest land use change in the shea value chain under different scenarios

Regional shea value chain W-Africa	Current situation 2018		Upgrading VC 2032			yield kernel/ tree	
	49 922 000	Ha					
Agroforestry cropped areas with shea trees	25 000 000	Ha	22 500 000	27	trees/ ha	4.0	kg
Set aside park land with shea trees	19 722 000	Ha	19 722 000	18	trees/ ha	3.0	kg
Improved agroforestry parklands (tree planting)	200 000	Ha	2 700 000	50	trees / ha	4.0	kg
Shrubland forest with scattered shea trees	5 000 000	Ha	5 000 000	6	trees/ ha	3.0	kg
Annual cropland enriched with shea trees	-	Ha	1 500 000	30	trees/ ha	4.0	kg
Total trees	1 070	million trees	1 172	million trees	103	million additional trees	

Source: screen print of FAO EX-ACT VC based shea model 2018

The upgrading scenario consists of over 2.5 million ha (10 percent of agroforestry cropped areas), transformed over 14 years in improved agroforestry parklands (50 trees per ha) while 1.5 million ha of annuals are enriched with shea trees, becoming agroforestry systems. Such a scenario represents an increase of 103 million additional trees by 2032.

Carbon fixed by the different shea perennial and agroforestry systems – parklands, agroforestry, forest shrubland – were computed using tier 2 carbon coefficients derived from a research article proposed to Environmental Research Letters: Revisiting IPCC Tier 1 coefficients for soil organic and biomass carbon storage in agroforestry systems (Cardinael, et al., 2018). The tier 2 SOC growth of 0.07 tC/ha, the tier 2 coefficient of above ground biomass growth of 0.59 tC/ha/year, and the below ground biomass coefficient of 0.21 tC/ha/yr, all specific to parklands in tropical dry Africa, were extracted from the aforementioned article and used in the current study as shown below in table 3.

Table 3: Perennial systems with tier 2 data based on Cardinael et al. 2018

3.1.2 Perennial systems remaining perennial system (total area must remain constant) :										
			Area concerned (ha)		**Tier 2 ABG Biomass growth (tC/ha/yr)**		**Tier 2 BLG Biomass growth (tC/ha/yr)**		**Tier 2 SOC growth (tC/ha/yr)**	
Perennial systems from other LU	**Residue/ biomass burning**	**Yield (t/ha/yr)**	***Current***	***Upgrading***		*Default value*		*Default value*		*Default value*
Perennial after Deforestation	NO		0	0		1.80		-		0.33
Perennial after non-forest LU	NO	0.04	0	1 500 000	0.59	1.80	0.21	-	0.07	0.33
Perennials staying as perennials:										
Agroforestry cropped areas with shea trees	NO	0.030	25 000 000			-		-	0.07	0.33
Improved harvest on agrof shea trees	NO	0.042	-	22 500 000		-		-	0.07	0.33
Set aside park land with shea trees	NO	0.008	19 722 000	19 722 000		-		-	0.07	0.33
Improved agroforestry parklands (tree planting)	NO	0.084	200 000	2 700 000	0.59	-	0.21	-	0.07	0.33
Shrubland forest with scattered shea trees	NO	0.002	5 000 000	5 000 000		-		-		0.33
		Total area	**49 922 000**	**49 922 000**						

Source: screen print of FAO EX-ACT VC based shea model 2018

4.4 Land use change in upgrading scenario

In terms of land use change at the regional level, about 1.5 million ha will benefit from progressive integration of shea trees in annual crop areas (through natural regeneration and assisted tree planting). It will create a land use change from annual crops to shea tree agroforestry farming systems.

4.5 From productive trees to effective collection and production

The production potential of shea trees is affected by the percentage of productive trees and the percentage of trees collected. It was previously estimated that only 42 percent of the shea fruits available are collected due to parklands accessibility, time, economic and transportation limitations by African women (Lovett, 2004).

Table 4 : Percentage of productive trees collected under different scenarios

	% of productive trees	Current situation 2018		Upgrading VC 2032	
		% trees collected	Yield/ ha T	% trees collected	Yield/ha T
Agroforestry with annual crop and shea trees	55%	50%	0.030	70%	0.042
Set aside land with shea trees	50%	30%	0.008	50%	0.014
Improved parklands in improved scenario	60%	50%	0.060	70%	0.084
Shrubland forest with scattered shea trees	50%	20%	0.002	30%	0.003

Source: screen print of FAO EX-ACT VC based shea model 2018

For 2018, GSA provided specific percentage (ranging between 20 percent and 50 percent) of trees collected for the different landscape systems, resulting in an average of 42.5 percent of trees collected in line with the above estimation (see table 4). In the upgrading scenario, improved access, transport facilities to women collectors, as well as improved economic incentives resulting from the development of cooperatives and access to storage significantly increase the percentage of trees collected.

The following production estimates were calculated taking into account yield per tree, tree density and percentage of productive and collected trees:

Table 5 : Total shea kernels produced, consumed and exported under different scenarios

	Tons in 2018		Tons in 2032	
Total production (kernel)	923 248	tons /year	1 505 097	tons /year
local consumption	*517 019*	*56%*	*827 803*	*55%*
export:	406 229	44%	677 294	45%
Processed for export	219 364	54%	440 241	65%
Exported as butter (T butter)	*46 066*		*92 451*	
Exported as stearin (T stearin)	*15 663*		*31 433*	
Exported as kermel	*186 865*	46%	*237 053*	35%

Source: screen print of FAO EX-ACT VC based shea model 2019

Currently, 43 percent of the production is exported, while 57 percent is consumed locally. The upgrading scenario assumes a production increase of 3.6 percent per year (a 63 percent increase by 2032). The export share will increase to 45 percent, representing an annual increase of export of 3.7 percent, much lower than world market expected increase (over 8 percent). The upgrading scenario also assumes an increase of local processing from 214 000 to over 440 000 tonnes, representing an increase of processed quantity for export by 5.1 percent per year in the region.

4.6 Volumes & price data per stakeholder

Bag size and weight may vary along the supply chain (from 100 kg in the village down to 85 kg in urban centres, and moisture content from 20 percent freshly post-harvest processed down to 7 percent in the late dry season). To facilitate the modelling, an average weight of 85 kg per bag was used throughout the value chain.

Using data collected from the GSA members, women collectors collect on average 4 bags of 85 kg of kernels, with 2 bags traded as kernels to intermediaries and 2 bags used for local processing of butter for local market consumption. With both trade and processing activities often being managed by the same household, they are both kept under the functions of the women collectors.

In the eight countries considered (Benin, Burkina Faso, Ivory Coast, Ghana, Guinea Conakry, Mali, Nigeria, Togo), there are around 2.4 million women collectors. In the upgraded scenario, women collectors increase quantities collected by 35 percent and are also processing most of the butter sold for local consumption.

Table 6 : Produce sold by collecting women under different scenarios

	85	kg/bag	Price per unit		Volume/ agent		Agents	Price / unit	Vol/ agent		agents
1 Collecting women (CW)					4.00	Bags	2 362 494		5.40	Bags	3 017 640
Sold in bags of shea nuts			23.96	USD per bag	2.02	Bags		26.25	2.64	Bags	
CW processing butter local consumption			0.83	USD per kg	57.1	kg butter		1.04	79.7	kg butter	

Source: screen print of FAO EX-ACT VC based shea model 2018

In addition to the 2.4 million women collectors, 4.8 million women engage in shea collection for self-consumption without market linkage, harvesting between 20-30 kg per year.

Three levels of intermediaries were considered: village intermediaries, regional intermediaries, and urban intermediaries. 5 800 village intermediaries deal on average 68 tonnes of shea kernels each (800 bags). At the regional level, 80 intermediaries are organized as wholesalers (4 800 tonnes / year) and are often registered as licence buying companies (LBC). Downstream, 13 urban gross intermediaries deal directly with processing companies and the export market, selling 28 000 tonnes on average.

Table 7 : Shea collection for self-consumption

			Current situation			Upgraded scenario		
	85	kg/bag	Volume/ agent		Agents	vol/ agent		agents
Micro- harvesting consumer women (50% women)			25	kg	**4 800 000**	25	kg	**4 800 000**
	home processed in butter		8.5	kg butter		8.5	kg butter	

Source: screen print of FAO EX-ACT VC based shea model 2018

12 large processors are active in the region, with 11 more forecasted for the upgrading scenario.

Table 8 : Active processors (country-wise) under different scenarios

Big processors	current	future
Ghana	7	10
Burkina Faso	2	3
Benin	1	2
Togo	1	1
Ivory Coast	0	1
Nigeria	1	5
Mali	0	1
Total	**12**	**23**

Source: GSA 2018

Table 9 : Produce traded by different agents across the shea value chain under different scenarios

85 kg/bag		Current situation: Price per unit		Volume/ agent		Agents	Upgraded scenario: Price / unit	vol/ agent		agents
1 Collecting women (CW)				4.00	Bags	2 362 494		5.40	bags	3 017 640
Sold in bags of shea nuts	sell	23.96	USD/ bag	2.02	Bags		26.25	2.64	Bags	
CW processing butter local consumption		0.83	USD/ kg	57.1	kg butter		1.04	79.7	kg butter	
		50% transf locally								
2. Village intermediaries	sell	27.55	USD/ bag	800	Bags	5 974	30.19	900	bags	8 854
3. Regional intermediary	sell	336.40	USD/ T	4 760	Tons	85	367	5 712	tons	119
4. Urban gross intermediary	sell	353.22	USD/ T	28 560	Tons	14	386	34 272	tons	19
5. Big Processors	buy	353.22	USD/ T	18 280	Tons	12	386	19 141	tons	23
50% Export as butter	sell	1 000	USD /T	3 839	tons	50%	1 050	4 785	tons	
50% export as stearin	sell	4 000	USD/ T	1 305	tons	50%	4 400	1 367	tons	
6. Urban Intermediary Export of kernel	sell	353	USD /T	186 865	tons		385	237 053	tons	
					Total	**2 368 580**				**3 026 654**

Source: screen print of FAO EX-ACT VC based shea model 2018

The price per bag sold by a collecting woman averages around USD 24, based on data from a GSA member survey on a sample of women collectors and intermediaries (held in August 2018), previous years' averages, and an Esoko study in February 2019. The price is also linked to the volume aggregated. With aggregation of group sales, women can earn 30-50 percent increased income compared to the village prices. Profitability and receipt of total perceived benefits, and major drivers of women's time investment in shea kernel collection are also key motivations of households for sustaining shea parklands. In order to assess economic return of collective women, we need to know the costs of collection and post-harvest processing, the prices offered to women shea nut collectors in relation to the quality of shea nuts, and the whole price structure in these chains. This deserves greater research investment if one keeps in mind that higher revenue received by collectors is a direct and positive reinforcing factor for sustainable shea parkland management decisions (Boffa, 2015).

4.7 Cost & labour work data at collection level

Information on costs and benefits, both economic and non-monetary, of competing demands on women's time and opportunities is key to better understanding how shea collection activities could be expanded and their profitability enhanced in relation to other options. Research is needed on the opportunity costs of women's time in shea-related activities in comparison with concurrent household and individual subsistence activities, child care and other potential income-generating activities. Various surveys (Pouliot, 2012) have established that a large majority (94 percent) of rural households in the shea belt are involved in shea kernel collection and fewer in the commercialization of shea products (59 percent) (Boffa, 2015).

Based on 2018 GSA survey, every collecting woman spends between 3 and 15 days for fruit harvesting. The 2019 survey on 400 women collectors provides much higher estimates for the collection work. Therefore 15 man days are used in our appraisal. Additional tasks considered are nut removal, wood collection, boiling and drying kernels, and transport.

Table 10 : Number of man-days for different shea activities

Crop production (man-days/ women)	
% of family labour	100%
Fruit collection	15.4
Nut removal from fruit	3.0
Wood collection	3.0
Boiling and drying nuts	2.0
Harvesting- farm transport	2.0
Local butter processing	18.3
Please fill up if no specified above	0
Total man-days per women	43

Methods for the traditional preparation of shea butter vary depending on locations, and the process involves the use of significant quantities of water and fuelwood, and the generation of waste. Shea butter production is also labour-intensive; in past studies reviewed (Elias, and, & Pouliot, 2013) labour involved in butter processing from kernels ranged from 2.5 hours to as many as 10 hours per person per kilogram of butter. However, a recent detailed assessment (Lovett, 2014) based on bulk volume processing of 85-100 kg sacks of shea kernels, appropriately reflects that processing practices and multitasking in women's groups brings this value to 30-45 minutes per kg of shea butter (Boffa, 2015).

In the present study, we use a workload of 2.5 hours per kg of butter processing as the regional average time, which translates to the equivalent of 14 working days of processing work per woman. Women selling handcrafted butter on export markets usually have a lower work time per kg of butter (Lovett, 2018).

Fuelwood is needed when roasting, smoking and/or boiling whole kernels and for the boiling of butter paste that is rinsed multiple times. Fuelwood estimates for handcrafted butter production vary between 8 to 10 kilograms of fuelwood per kg of shea butter. In Eastern Burkina Faso, a study (Noumi, Dabat, & and Blin, 2013) showed that it took 7.9 kg of wood to produce 1 kg of butter (4.3 kg for processing into kernels and 3.6 kg for processing into butter) with traditional methods (Boffa, 2015)

On this basis the study does account 3.37 kg of wood per kg of kernel produced in the value chain (with 60 percent of all the produced kernel being processed in butter locally).

Table 11 : Amount of fuelwood consumed for different shea activities

Wood consumption	
2.15	kg of wood for producing 1 kg kernel
3.60	kg of wood per kg of local butter processing
1.22	kg of wood per kg of kernel transformed in butter
3.37	kg of wood per kg of kernel for both processing and butter transformation

40 percent of the wood is collected as residue in agroforestry and set-aside land but 60 percent is obtained from above ground biomass of forests through deforestation. This wood consumption currently generates about 10 053 ha of deforestation of tropical dry forest per year in the West Africa region. This has been taken into account for the carbon balance calculation.

Table 12 : Fuelwood collected and area of forest lost under different scenarios

	Current situation	Future situation
000 tons of wood consumed per year by Shea	2 618	4 249
000 tons of carbon of Above ground biomass	861	1 398
% extracted by deforestation	60%	40%
% from agroforestry and waste biomass	40%	60%
51.4 Ton C of AGB lost when deforesting one ha of dry forest in set aside		
Ha of dry forest lost per year	10 053	10 879
ha deforested on 2018-2032	140 742	152 306

Source: screen print of FAO EX-ACT VC based shea model 2018

The upgrading scenario assumes reduced wood energy consumption and reduced sourcing through deforestation (from 60 percent to 40 percent).

4.8 Cost data for intermediaries

Village intermediaries, who trade about 110 -120 tonnes of shea kernels per year, have low storage cost (equipment and maintenance of building) and staff cost (1 worker during 5 months assumed). Their main costs are transport costs for 205 km of distance, estimated at USD 13.3 per ton of shea kernel (inclusive of labour). This represents an annual cost of USD 1 700-1 800.

Table 13 : Costs of village intermediaries

Village Intermediary		**USD**
Transport cost per tonne for 205 km		13.00
Other costs per village intermediary per year		**USD per intermediary**
Storage equipment		104.17
Taxes		0.00
Credit cost		0.00
Maintenance and reparation of truck		0.00
Staff cost	nb	312.50
5 months		

Regional downstream intermediaries, who collect around 6,000 tonnes per year, have higher staff, truck, and credit costs. These intermediaries have 3 trucks (either their own or affiliated operators), with an average load of 18 tonnes. In line with kilometres covered (400-500 km) by trucks (2 days per transport), about 137 truck operators are mobilized (assuming 3 trucks per operator).

Table 14 : Details on trucks operated by intermediaries

Regional -downstream intermediary	**USD**
Transport cost per tonne for 240 km	15.22
Other costs per downstream intermediary per year	**USD per intermediary**
Storage equipment - maintenance	729.17
Taxes	-
Credit cost	416.67
Maintenance and reparation of truck	937.50
Staff cost	2 812.50

Table 15 : Details on trucks operated by intermediaries

Quantity transported / truck	18	
Nb of L consumed / truck per 100 km	25	
Nb of truck operators	150	
Assumption: 1 collector = X1 trucks x X2 truck loads / year x quantity transported	2700	tonne collected
		Tier 2
Truck load* to be changed at tier 2 if different:	100	50
Number of truck per operator	1	3

Diesel consumption and labour mobilized, and wages for transport are based on the following estimations:

Table 16 : Downstream transport and labour costs

Downstream transportation	km	price of fuel per litre	USD per tonne
	945	5	27.34
Downstream transportation labor		**Wage**	**salary USD per tonne**
Nb of driver-eq (manday)	69	30	0.58
Nb of driver assistants-eq (manday)	69	15	0.29
Assumptions: 2 assistants per driver, if not please change:	1		

4.9 Consumables for large processors and exporters

The value added is computed assuming that 70 percent of produced kernel is processed to shea butter, with 40 percent extraction rate and a price of USD 1 000 per ton. The remaining 30 percent of kernels are processed to stearin at an extraction rate of 14.28 percent, and a price of USD 4 000 per ton.

Table 17 : Details on big processors' shea trading under different scenarios

				Current situation					Upgraded scenario			
	85	kg/bag		Price per unit		Volume/ agent		Agents	Price / unit	vol/ agent		agents
5. Big Processors			buy	353.22	USD/ T	18 280	tons	12	386	19 141	tons	23
50%	Export as butter		sell	1 000	USD /T	3 839	tons	50%	1 050	4 785	tons	
50%	Export as stearin		sell	4 000	USD/ T	1 305	tons	50%	4 400	1 367	tons	

The intermediary inputs per ton of processed shea kernel include electricity, gasoil, paper, plastic, jute bags. Labour mobilized has been calculated based on per ton of production.

Processors, when buying in bulk, have expectations of "average quality". While not all buyers reward quality kernels with higher prices, some are offering quality bonuses through direct sourcing schemes.

Table 18 : Details on intermediate processing inputs, as displayed on the EX-ACT VC tool

Intermediate processing consumption / tonne of production shea nut -> shea butter			
tons of shea nuts processed in butter 18 280		Unit	Production cost (USD)
Additives per tonne of production	0	kg	-
Energy consumption	0	0	-
Electricity use (kWh)	98.46	*kWh*	16.41
Wood (in t d.m.)	-	*kg*	-
Peat (in t d.m.)	-	*kg*	-
Butane	-	*m^3*	-
Propane	-	*m^3*	-
Ethanol	-	*m^3*	-
Gas (LPG/natural)	-	*litre*	-
Gasoil/Diesel	15.10	*litre*	16.04
Gasoline	0	*litre*	-
Electricity use for storage	-	*kWh*	-
Other cost	9.33	litre	9.13
Packaging cost			
Wood	0	*kg*	-
Glass	0	*kg*	-
Paper and card	20	*kg*	12.50
Steel	0	*kg*	-
Aluminum	0	*kg*	-
Plastic (mixed)	30	*kg*	16.25
Plastics LLDPE	0	*kg*	-
Fish crates	0	kg	-
Ice	0	kg	-
Jute bag	15	*kg*	15.63
Labor per tonne of production per processing unit			
Full time practical workers employee	0.40	*MD/t*	5.10
Full time manager employee	0.10	0	4.18
Seasonal employee	0.20	0	1.39
Others	0.00	0	0.00
Total man-days per tonne	**0.70**	0	0

5 CURRENT SOCIO-ECONOMIC IMPACT AND CARBON FOOTPRINT

5.1 Labour generated

Based on labour mobilized at the level of collecting women and assuming 250 days of work per year, the regional value chain represents an equivalent of 420 000 full time employments. The reality is closer to 3.5 million seasonal employments of 30 days per year. Every day of work generates USD 1.9 of value added for women.

5.2 Income level for women collectors

Shea production is often a secondary activity for women. Therefore, a drop in production caused by climate change impacts is less of a concern than it is for other crops (e.g. cereal) that are necessary for subsistence (Venturini, et al., 2016). However, shea is an important crop for women. At the household level, this income represents up to 12 percent of the total income and up to 32 percent of the cash. Shea income is received during the lean season, which makes it particularly valuable to bridge the gap between two harvests. Unlike most agricultural cash crops, women traditionally have retained control of shea-related revenues, usually spending it on education, health insurance, and other social services. According to a study in Northern Ghana, 90 percent of women view shea as the major source of their livelihoods.

Table 19 : Socio-economic performances of the shea value chain (under the current scenario)

Socio-economic performances of the value chain		Current
Production level : Collecting women and local butter processing		
	Nb of HH	0
	Nb of employement-eq	408 617
Gross production Value (GPV)		**226 990**
Value Added (VA)		**178 043**
Gross Income (GI)		**178 043**
VA / tonne of product		**193**
VA / HH		**75**
Gross income / HH		**75**

Source: screen print of FAO EX-ACT VC based shea model 2018

The gross income per woman collector at USD 75 is much higher than a preceding study that estimated USD 33 per collecting woman in Ghana (Laube, 2015). This income is consistent with our definition of women collectors as agents selling their collected products. Furthermore, in this study, women collectors' income also includes income from local butter processing.

This level of income has implications for the sustainability of the shea value chain. Total perceived benefits are both major drivers of women's time investment in shea kernel collection and key household motivations for sustaining shea parklands.

5.3 Value added of the whole value chain

Figure 7 represents the value added at each level of the chain.

In West Africa, shea has a gross production value of about USD 284 million and a value added of USD 203 million, mostly captured at local production level by women collectors and local processors.

Intermediary agents and collectors, estimated to be over 6 000 operators, show an average income of USD 2 000 through shea.

Processing units are mid-size enterprises with about 35 permanent staff and 15 temporary staff. They obtain a relative low percentage of the value added (5 percent) since they only process part of the production. They are only 12 currently active with a gross income of around USD 600 000.

Figure 7: Value added (USD '000) under the current scenario

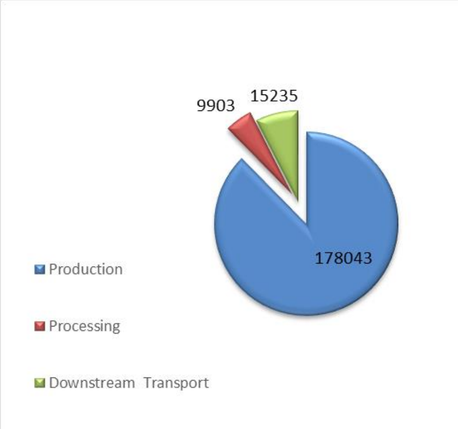


Table 20 : Value added (USD) based on value chain level (under the current scenario)

Socio-economic performances of the value chain		Current
Production level : Collecting women and local butter processing		
	Nb of HH	0
	Nb of employement-eq	408 617
Gross production Value (GPV)		**226 990**
Value Added (VA)		**178 043**
Gross Income (GI)		**178 043**
VA / tonne of product		**193**
VA / HH		**75**
Gross income / HH		**75**
Intermediary agents and transportation level		
	Nb of operator eq	6 224
	Nb of employement-eq	6 608
Gross production value		**27 551**
Value added		**15 235**
Gross income		**12 694**
VA / operator		**2 306**
Gross income / operator		**2 090**
Downstream processing Actors		
	Nb of operator-eq	12
	Nb of employement-eq	614
Gross processed production value (GPPV)		**31 234**
Value added		**9 903**
Gross income		**7 534**
VA / tonne of product		**160**
Gross income / operator		**627 821**
Aggregated Socio-economic performances		**Current**
Value added		**203 181**
Gross production value		**285 774**
Total job generated		**415 839**

Source: screen print of FAO EX-ACT VC based shea model 2018

5.4 Carbon footprint in the current situation

Developing a carbon footprint is similar to developing a lifecycle analysis (LCA), and many of the carbon footprint methods currently in use are based on the ISO method for LCA, ISO 14040/44 (Bockel, Touchemoulin, Jönsson, & Cortéz, 2011). Carbon footprint is used to describe the quantity of GHGs generated by a product or activity, and is expressed in tonne of CO_2 equivalent per tonne of product (tCO_2-e per tonne) of all GHGs emitted over the entire life cycle of a product (Lashermes, 2018).

Currently, the shea value chain fixes about 1.5 million tCO_2 yearly. The carbon footprint per ton of shea kernel produced is -1.8 tCO_2 at the production level.

Table 21 : Climate dimension of the shea value chain under the current scenario (mitigation and carbon footprint)

Climate Mitigation dimension of the Value Chain	Current
GHG impact (tCO_2-e per year)	-1 502 735
GHG impact (tCO_2-e per year per hectare)	0.0
Carbon footprint of production (tCO_2-e per tonne of product)	-1.8
Annual tCO_2-e [emitted (+) / reduced or avoided (-)]	
Annual tCO_2-e from renewable energy	
Equivalent project cost per tonne of $CO_{2\text{-}e}$ reduced or avoided (in USD on 20 years)	
Equivalent value of mitigation impact per year (USD 30/tCO_2-e)	
Equivalent value of mitigation impact per year per ha (USD 30/tCO_2-e per year per ha)	

Carbon footprint at the different levels of the Value Chain	tCO_2-e per tonne of product Current
PRODUCTION	-1.79
PROCESSING	0.53
TRANSPORT	0.21
TOTAL	-1.05

Source: screen print of FAO EX-ACT VC based shea model 2018

The whole carbon footprint inclusive of downstream activities is estimated at -1.13 tCO_2/ ton of shea kernel, or 3.05 tCO_2 fixed per ton of shea butter.

To assess how the carbon footprint of shea butter compares to that of other oils used, either for food or other consumption (health, beauty), we used both olive oil and palm oil. Olive oil produced in Italy fixes 0.794 kg of CO_2 per litre of olive oil (Proietti, Sdringola, Evangelisti, & Luca, 2018). Palm oil produced in Colombia varies between −3.0 to 5.3 kg CO_2eq per kg of palm oil depending on land use, e.g. whether deforestation of tropical forests or plantation on previous cropland. The highest result (worst) is obtained if tropical rainforest is converted (deforestation) and the lowest (best) of -3 kg CO_2eq per litre of palm is planted on previous cropland, savannah (Castanheira, 2014). In both cases, shea positions as a much better carbon-fixing product. Therefore, the current value chain situation demonstrates that shea comes out as a highly green, low carbon product.

Measuring the carbon footprint of a product across the supply chain is a recent trend that has several benefits. It is an opportunity for businesses to reduce their emissions in a more effective way, after having identified the main GHG sources; it can save them money as well and become a tool for supply chain decision making and management. When carbon footprint accounting is associated with the display of a carbon footprint or carbon reduction label, it provides further advantages for both the public and private sector, whose interaction and collaboration is essential for the success of carbon labelling objectives. Companies find carbon labelling as a way to differentiate themselves on the market, gain new market share, and build a better brand image (Bockel, Touchemoulin, Jönsson, & Cortéz, 2011).

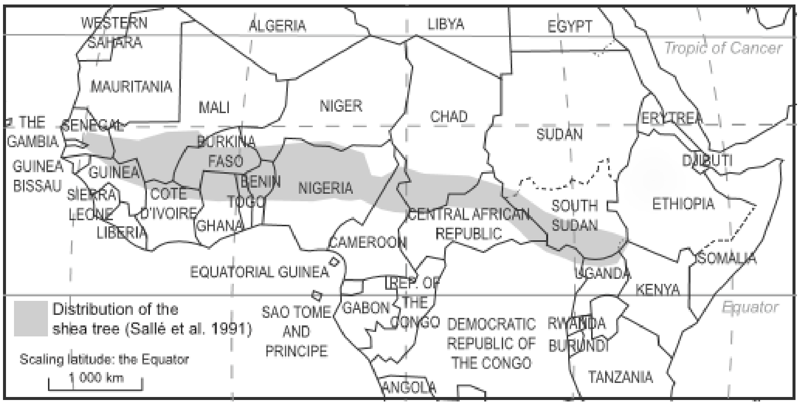
6 UPGRADING SHEA VALUE CHAIN SCENARIO (2018-2035) AND PROJECTED IMPACT

6.1 Drivers

6.1.1 *Policy context: Africa's Greet Green Wall (GGW)*

The targeted area of Africa's Great Green Wall (see figure 9) links well with the shea distribution map (figure 8) in Africa.

Figure 8: Map of shea distribution in Africa



Source: Salle, Boussin, Raynal-Roques, & Brunck, 1991
Conforms to the UN World map, February 2019

Figure 9: Africa Great Green Wall

Conforms to the UN World map, February 2019

The Great Green Wall for the Sahara and Sahel Initiative is an African Union initiative to transform the Sahel into a stable, sustainable, resilient region through improved management of natural resources, land, water, and climate risks. Led by the African Union, Heads of State of more than 20 countries in the region endorsed the development of the initiative, recognizing that natural resources, climate change, water, agriculture, jobs and security are interconnected challenges that impact poverty and prosperity. Since 2014, the World Bank has partnered with 12 countries and the Global Environment Facility (GEF) to develop the USD 1.1 billion Sahel and West Africa Program (SAWAP) in support of the Great Green Wall.

6.1.2 *Sustainable parkland management*

Shea parklands are managed landscapes where shea and other economically valuable species have been favoured by local farming communities through cyclical selection and management for generations. Consequently, development activities that enhance income and other benefits derived from the trees will directly encourage more active parkland and forestry management, maintenance and enrichment.

To scale such an approach, improved management of the shea resource should not be circumscribed to the planting of improved shea stands in the proximity of farmers' compounds. Instead it needs to be an integrated landscape-wide approach combining a series of relevant parkland regeneration, and tree improvement and management interventions in fields, fallows, bush lands that make up village landscapes. The interventions also need to address income generation for communities and value chain competitiveness to ensure economic benefits through tree protection and regeneration.

In other words, a wide rehabilitation and sustainable reorientation of shea value chain could be part of a wider integrated landscape greening approach of Sahel countries, to cumulate co benefits in terms of value added, income distribution, gender impact, carbon fixing and GHG mitigation, and climate resilience.

Domestication of parkland species may proceed most actively in localized niches of relatively high management intensity. Trees improved through modern domestication methods may increase farmers' interest in maintaining and expanding their investment in parkland agroforestry. This requires tree planting, a growing but not strongly rooted practice in the Sahel.

Where there is a demand for tree planting, government, decentralized seed centres and nurseries need to support it by developing flexibility and responsiveness to the needs of farmers, and drawing on indigenous knowledge for the propagation of desired parkland species (Boffa, 1999).

Within a wide scale regional initiative targeting over 100-200 million trees planted –regenerated in 10-15 years (7-15 million trees per year), a whole network of operators will need to be mobilized, including decentralized authorities at district level and technical agriculture and forestry services in charge of production, for the delivery of tree seedlings. It will need to support the creation of seedlings and advice delivery to micro-enterprises.

6.1.3 *Economic incentives*

Farmers invest actively in the protection and reproduction of parklands whenever they perceive that trees and their products are becoming more valuable, either because of increased demand or declining availability. They also strengthen or construct institutional arrangements and maintain the necessary knowledge base for the management of these systems. In contrast, farmers tend to neglect their forest resources and favour alternative agricultural practices, items of consumption and income-earning activities, when these yield higher benefits than parkland-related activities. Important decision-making factors are lower costs, higher revenues, lower labour expenditure, better product availability, greater subsistence priority, preferred taste (Boffa, Opportunities and challenges in the improvement of the shea (Vitellaria paradoxa) resource and its management, Occasional Paper 24. , 2015).

Consequently, ensuring increased incomes for women collectors through the organization of cooperatives and access to storage infrastructure can influence the conservation and regeneration of parkland resources. Collection and processing are often time-consuming, labour-intensive, and result in low efficiency. Additional support can go towards the identification of appropriate, cost-effective technologies with higher extraction yields, lower labour demands, and durable equipment (Boffa, Agroforestry parklands in sub-Saharan Africa - Chapter 8, 1999). These include improved cookstoves, grinding machines, donkey carts, bicycles and cooking material (Naughton, Deubel, & Mihelcic, 2017).

At the same time, continuous investment needs to be undertaken in the shea value chain competitiveness to ensure strong demand for shea and to maintain the inventive system.

Another key incentive that can be provided is a payment of environment service (PES) based on the number of trees planted and kept on farming plots.

6.2 Targets for the upgrading scenario

Incorrectly perceived as wild, untameable, and slow to mature, shea trees are in reality quite conducive to improved management. Shea is easily propagated from both fresh seed (fruition within 7–15 years after planting) and grafted scions (fruiting within 3–5 years). With tenurial changes, skill transfer, and financing solutions, parkland restoration can become a viable option. Incentives need to be offered for commercial shea nurseries and the breeding of early maturation, regular-, and high-yield varieties. On-farm trials of intercropped shea, farmer-managed natural regeneration (FMNR), and the replanting of shea with other indigenous trees can be a part of climate-smart agroforestry programs that can increase both annual tree and crop productivity. In West African targeted countries, approximately 40 million ha of parklands are targeted with the expansion of shea trees planted per ha over the next 10 years.

The upgrading scenario 2018-2032 has the following objectives:

- To support 3 million women shea collectors to be organized in cooperatives, improving collection, processing and post-harvest management
- Promote tree density and effective harvesting of shea trees in agroforestry cropped areas
- Increase in tree density from 18 to 50 per ha on 2.5 million hectares of set aside parklands transformed in agroforestry improved parklands
- 1.5 million ha of annual cropland enriched with shea trees

This scenario is based on the following considerations: upscaling of the GSA sustainability program, large scale land restoration initiatives such as Evergreen Agriculture, Ghana Shea Landscape REDD+ Program, Great Green Wall etc.

This upgrading scenario 2018-2032 is low profiled in yield per tree, percent of trees collected, trees per ha in improved parklands, which stay equivalent to the current situation. However, such a scenario represents an increase of 207 million additional trees, and require a wide range of forestry services with low cost tree-seedlings and appropriate extension support targeted to shea collector cooperatives, municipalities, local forestry services, NGOs, and on-going support projects active in agroforestry development within the region.

6.3 Socio-economic impact of shea value chain upgrading scenario

The upgrading scenario results in a significant increase in employment by 2032, with 260 792 additional jobs created and about 3.7 million women collectors mobilized in West Africa.

For the whole value chain, the gross production value will reach USD 593 million, equivalent to an economic growth of about 6.3 percent per year for 14 years. The value added is estimated at USD 452 million (+108 percent over 14 years).

Table 22 : Socio-economic performances at each level of the shea value chain under different scenarios

Socio-economic performances of the value chain	Current	Upgrading	Balance	
Production level : Collecting women and local butter processing				
Nb of HH	0	3 017 640		
Nb of employement-eq	408,617	665 719	257,102	jobs
Gross production Value (GPV)	**226 990**	**459 844**	232 855	000 USD
Value Added (VA)	**178 043**	**383 441**	205 398	000 USD
Gross Income (GI)	**178 043**	**383 441**	205 398	000 USD
VA / tonne of product	**193**	**255**	62	USD
VA / HH	**75**	**127**	52	USD
Gross income / HH	**75**	**127**	52	USD
Intermediary agents and transportation level				
Nb of operator eq	6 224	9 241		
Nb of employment-eq	6 608	9 856	3 248	jobs
Gross production value	**27 551**	**49 504**	21 953	000 USD
Value added	**15 235**	**29 775**	14 541	000 USD
Gross income	**12 694**	**25 976**	13 282	000 USD
VA / operator	**2 306**	**3 021**	716	USD
Gross income / operator	**2 090**	**2 636**	545	USD
Downstream processing Actors				
Nb of operator-eq	12	23		
Nb of employment-eq	614	1 057	442	Jobs
Gross processed production value (GPPV)	**31 234**	**84 092**	52 858	000 USD
Value added	**9 903**	**39 138**	29 235	000 USD
Gross income	**7 534**	**34 914**	27 380	000 USD
VA / tonne of product	**160**	**277**	116	USD
Gross income / operator	**627 821**	**1 517 985**	890 164	USD
Aggregated Socio-economic performances	**Current**	**Upgrading**	Balance	
Value added	**203 181**	**452 354**	**249 173**	000 USD
Gross production value	**285 774**	**593 440**	**593 440**	000 USD
Total job generated	**415 839**	**676 631**	**260 792**	Jobs created

Source: screen print of FAO EX-ACT VC based shea model 2018

Table 23 : The social footprint of the shea value chain under different scenarios

Social Footprint	Current	Upgrading	
Days of labour per ton of shea butter	282	281	*working days/ T*
Pro-poor Value added per ton of Shea Butter	482	637	*USD/ Ton*
Income generated per day of work at production level	1.74	2.30	USD/ working day
Gender : part of labour allocated to women	59%		
Labor from young adults /other family members	39%		

The "social footprint" indicator analyses the labour intensity, pro-poor value added distribution, return per day of labour and gender dimension of the value chain. The value chain has the following social footprint: high labour intensity of shea butter and low income generated by day of labour. However, the upgrading scenario demonstrates a significant potential of increased income per day (+33 percent).

6.4 Carbon balance and carbon footprint generated

The upgrading scenario results in an annual GHG reduction impact of around 10.5 million tCO_2e per year. Compared to the current situation, the scenario represents an incremental carbon balance of 9 million tCO_2e per year and a total carbon balance of 180 million tCO_2 over 20 years.

Consequently, the shea value chain provides an efficient carbon fixing mechanism with a cost of USD 0.89 per ton of CO_2 fixed. The economic value of such a positive externality could be around USD 270 million per year, making the value chain a high mitigation return investment. This mitigation potential is completed by a high resilience impact generated by the value chain upgrading on landscapes and households. Such resilience impact will be strategic considering West Africa and the Sahel's climate change hotspot status. According to the scientific findings of the Intergovernmental Panel on Climate Change (IPCC), temperatures over West Africa are projected to rise by 3 °C to 6 °C by 2100, with unprecedented climate conditions occurring by the 2040s (IPCC, 2014).

Table 24 : Climate dimension of the shea value chain under different scenarios (mitigation and carbon footprint)

Climate Mitigation dimension of the Value Chain	Current	Upgrading	Balance
GHG impact (tCO_2-e per year)	-1 502 735	-10 494 693	
GHG impact (tCO_2-e per year per hectare)	0.0	-0.2	-0.2
Carbon footprint of production (tCO_2-e per tonne of product)	-1.8	-8.7	-6.9
Annual tCO_2-e [emitted (+) / reduced or avoided (-)]		-8 991 958	
Annual tCO_2-e from renewable energy		0	
Equivalent project cost per tonne of $CO_{2\text{-}e}$ reduced or avoided (in USD on 20 years)		0.85	
Equivalent value of mitigation impact per year (USD 30/tCO_2-e)		269 758 737	
Equivalent value of mitigation impact per year per ha (USD 30/tCO_2-e per year per ha)		5	
Carbon footprint at the different levels of the Value Chain	**tCO_2-e per tonne of product**		**Balance**
	Current	**Upgrading**	
PRODUCTION	-1.79	-8.73	-6.95
PROCESSING	0.53	0.48	-0.05
TRANSPORT	0.21	0.21	0.00
TOTAL	-1.05	-8.04	-6.99

Source: screen print of FAO EX-ACT VC based shea model 2018

Related to production level, the upgraded carbon footprint performance has increased to -8 tCO_2 fixed per ton of shea kernels. This carbon footprint is inclusive of the carbon fixed by landscape rehabilitation and improved parklands. The exceptionally low carbon footprint is 100 percent attributed to the green carbon fixing impact of the rehabilitation and improvement of shea parklands, which is the core of the upgrading strategy. It allows for an easy comparison with the current rehabilitation strategy of the cocoa value chain in Ghana (FAO working document, 2019), which provides a negative carbon footprint of -4.3 kg of CO_2 per kg of cocoa. Such negative carbon footprints demonstrate the substantial scope for climate mitigation through the expansion or rehabilitation of agroforestry value chains.

7 INVESTMENT COSTS FOR THE UPGRADING SCENARIO

7.1 Assumptions

The upgrading strategy targets are summarized in the table below, with about 103 million additional shea trees and 3 million women collectors supported.

Table 25 : Targets of the upgraded shea value chain

	Global Target	Unit
Collecting women targeted	3.01	Million W
Number of new trees	103	Million T
Additional trees per year	7.35	Million T
Crop area switched to shea agroforestry annual crop area	1 500 000	ha
Target per year	107 142.86	ha
Shea agroforestry area improved	2 500 000	ha
Target per year	178 571.43	ha
Women cooperatives	3 772	units

These targets assume that 80 percent of the tree renewals will be achieved through farmer-managed natural regeneration (achieved through training and extension support), the remaining 20 percent will be achieved through direct planting, either by women collectors, CW associations-groups, communities, villages, local forestry services, or NGOs.

Table 26 : Details of tree renewal costs

	Global costs	Unit
Part of new trees resulting from NRA	80%	
Total trees from NRA	82 400 000	trees
Part of new trees directly planted	20%	
Total trees planted	20 600 000	trees

7.2 Investment costs estimates

7.2.1 *Tree planting costs*

The specific prices and unit costs used for this budget are provided in the table below.

Table 27 : Tree planting costs

Price applied per shea seedling (one year old)	1	USD
Cost of planting by service provider	4	USD
Extension cost to promote NRA trees/collecting women (trinaing)	5	USD

Nurseries will be supported for set-up, and management and they also benefit from a demand market supported by the project (price of USD 1 /plant). The foreseen support should fund the whole purchasing cost of seedlings and planting.

Service providers planting for villages / communities have a cost of USD 4 per tree), while CW and women groups who plant for themselves could be remunerated through a PES equivalent to USD 2 per tree. It should be applicable only for CW having planted at least 10 trees. Overall, new trees have the following costs:

Table 28 : Total tree planting costs

Total cost of purchase of seedlings	41 200 000	USD
Total cost of planting (service providers and PES)	57 680 000	USD
Total cost of NRA extension	16 000 000	USD

7.2.2 *Warehouse, cookstoves and nurseries*

In terms of investment support for warehouse building and improved stoves, the project could cover building costs of cooperatives (groups of collective women) as follows -

Table 29 : Total equipment costs for cooperatives

Warehouses to build and improved oven for cooperatives	2 000	Units
Cost per warehouse	10 000	USD
Improved heating oven	2 000	Units
Cost per improved heating oven	500	USD
Other equipment	200	USD/unit
Total cooperative-group equipement cost	21 400 000	USD

Support for the installation of new nurseries or rehabilitation of nurseries will also be partly covered by the project to promote expeditiously an appropriate supply of seedlings. It should represent nearly USD 5 million (34 big nurseries with USD 40 000 investment per nursery support and 440 small nurseries-cooperatives with USD 8 000 investment support).

7.2.3 *PPP and technical support cost*

Furthermore, the programme should partly support private processing investments either through subsidy or through building access facilities (6 million budget allocated). FAO will provide support on impact and M-E monitoring and strengthen FAO-GSA knowledge sharing and policy support.

Table 30 : PPP, Technical support and administrative costs

Processors investment support		
Public private partnership support	6 000 000	USD
FAO-GSA Knowledge sharing and policy support		
FAO-GSA technical support- knowledge platform	2 000 000	USD
FAO-GSA M-E and policy support	1 200 000	USD
FAO-GSA Admin and Management Cost		
FAO-GSA Project management and othercost (5%)	7 274 000	USD

7.3 Total programme cost

This corresponds to an estimated global cost of USD 153 million for the eight countries covered by the regional value chain: Ghana, Burkina Faso, Togo, Benin, Nigeria, Cote d'Ivoire, Guinee Conakry and Mali. Out of this USD 153 million of public investment, USD 30 million has already been mobilized by the private sector, through the USAID Sustainable Shea Initiative and the Ghana Shea Landscape REDD+ project. Consequently, the remaining investment to be financed by donor and other stakeholders is USD 123 million. In line with the country production, about 89 percent should be allocated to the main producing countries: Ghana, Burkina Faso, Nigeria, Mali and Ivory Coast. Additional private sector investments downstream should be also considered around 20 million USD per year (USD 120 on first 6-7 years).

Table 31: Total programme cost

Seedling-extension planting and env service cost		
Total cost of purchase of seedlings	41 200 000	USD
Total cost of planting (service providers and PES)	57 680 000	USD
Total cost of NRA extension	16 000 000	USD
Cooperative investment-equipment support		
Total cooperative-group equipment support	21 400 000	USD
Processors investment support		
Public private partnership support	6 000 000	USD
FAO-GSA Knowledge sharing and policy support		
FAO-GSA technical support- knowledge platform	2 000 000	USD
FAO-GSA M-E and policy support	1 200 000	USD
FAO-GSA Admin and Management Cost		
FAO-GSA Project management and othercost (5%)	7 274 000	USD
Total Programme Cost	152 754 000	USD

7.4 Economic analysis of public – private investment return on the value chain (IRR, NPV)

In order to appraise the economic return of investment in the shea value chain growth scenario, we used the incremental value added per year and the incremental economic value of carbon mitigation impact generated to be balanced against public and private investments spent.

The table below presents the value chain's economic performance on the basis of incremental value added. It allows one to assess the investment return without taking into account the resulting carbon benefits. Using USD 153 million of public investments and USD 120 million of private investments, the net present value (NPV) generated at the regional level is USD 792 million, with a discount rate of 10 percent, while the internal rate of return (IRR) is 56 percent.

Table 32: Economic analysis of investment return without accounting carbon impact

Economic Analysis of the performance of the Value chain		
Incremental value added per year	249,173	000 USD
Incremental carbon balance per year	-8,991,958	TCO_2 per year
Social price of the ton of CO_2	0	USD
Economic value of carbon mitigation impact	0	000 USD/year
Total public investment cost on 10 years	153 000	000 USD
Total proxy of private investment	120 000	000 USD

	% impact accounted	*0%*	*10%*	*20%*	*30%*	*40%*	*50%*
000 USD		**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
Incremental value added		0	24 917	49 835	74 752	99 669	124 587
Incremental carbon eco value		0	0	0	0	0	0
Public Investment cost	*153 000*	30 600	30 600	22 950	22 950	15 300	15 300
Private investment cost	*120 000*	24 000	18 000	18 000	12 000	12 000	12 000
	Cash Flow	-54 600	-23 683	8 885	39 802	72 369	97 287

NPV	**USD 792 380**	000
IRR	**56%**	

The next table provides the same type of analysis while accounting for the carbon balance impact with a social price of USD 32 per ton of CO_2e. This effectively results in a NPV close to USD 2 billion and an IRR over 100 percent which translate as a positive message to public investors. The discounted return per dollar invested is over USD 7.

Table 33: Economic analysis of investment return with carbon mitigation impact

Economic Analysis of the performance of the Value chain			
Incremental Value added per year	249 173	000 USD	
Incremental Carbon Balance per year	-8 991 958	TCO_2 per year	
Social price of the ton of CO_2	32	USD	
Economic value of Carbon mitigation impact	287 743	000 USD/ year	
Total Public investment cost on 10 years	153 000	000 USD	
Total proxy of private investment	120 000	000 USD	
		% impact accounted	*0%*
	000 USD		**2020**
	Incremental value added		0
	Incremental carbon eco value		0
	Public Investment cost	*153 000*	30 600
	Private investment cost	*120 000*	24 000
		Cash Flow	-54 600
	NPV	**USD 1 934 222**	000
	IRR	**110%**	

8 CONCLUSION

Using the Ex-ante Carbon Balance Value Chain Tool (EX-ACT VC), this paper assesses the current contribution of the shea value chain in West Africa towards climate mitigation, climate resilience and socio-economic impact, and its potential to significantly scale such impact through an expansion strategy by 2032.

The expansion strategy would involve improving the value chain through the following measures:

i. increasing tree density and effective shea harvesting by tree planting in agroforestry cropped areas,
ii. transforming 2.5 million ha of agroforestry cropped areas to agroforestry parklands over 14 years,
iii. enriching 1.5 million ha of annual cropland with shea trees, effectively creating additional agroforestry systems, and
iv. developing cooperatives and improving access, transport facilities, and storage for 3 million women shea collectors.

Shea has an enormous potential to mitigate climate change in West Africa. Therefore, through donor and private partner support, this expansion strategy can:

i. increase the shea tree population by 7 million additional trees per year,
ii. fix 9 million tonnes of CO_2e per year (i.e. 180 million tonnes of CO_2e over 20 years), resulting in 8 tonnes of CO_2e reduced per ton of shea kernel produced,
iii. generate a 33 percent increase in income per working day for women collectors (from USD 1.74/day to USD 2.30/ day),
iv. increase employment, with approx. 260 000 additional jobs by 2032,
v. create a gross production value of approx. USD 593 million (economic growth of about 6.3 percent per year till 2032) for the value chain, and
vi. generate a Net Present Value of USD 1.9 billion after investment and an internal rate of return of over 100 percent when accounting for both public and private investments – making it a very efficient option for spending public funds.

Implementing such a strategy will make a marked impact in mitigating the effects of climate change and enhancing the climate resilience and livelihoods of those living in West Africa, making the shea value chain a key Pro-Poor Carbon-Fixing Engine for the region. By linking it with other regional value chains, such as cashew and gum, the shea value chain could be part of a regional agroforestry scaling up initiative in line with the Africa Climate Business Plan (ACBP) and the vision of accelerated transformation in the Malabo Declaration.

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