Intensification of Agriculture and Agroforestry Technologies (IAAT) for Climate Resilient Food and Nutrition Security: Tombouctou, Gao, Mopti, Koulikoro and Segou Regions of Mali

Annex 22: GHG Emission Reduction Estimates

Accredited Entity: Save the Children Australia

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MITIGATION TARGET OF THE PROJECT

The project will achieve a mitigation impact through components 1 and 2 and specifically the following activities:

- Activity 1.2.1 Build awareness, capacity, community interest and field-level adoption of CSA techniques and agroforestry amongst smallholder farmer communities (crop and/or livestock)
- Activity 1.3.2 Plant agroforestry trees on community and state-owned lands
- Activity 2.3.1 Install and support the productive use of biodigester systems and solar irrigation systems among smallholder farmers

Each of these activities is further detailed below.

Activity 3.1.1: Install and support the productive use of biodigester systems and solar irrigation systems among smallholder farmers.

This activity will increase the productivity and revenue of smallholder farmers whilst reducing GHG emissions of farms by supporting the adoption of mitigation and adaptation technology and their associated markets in Mali. The activity will install 1000 solar irrigation systems (200 large solar irrigation systems with 5 HP capacity, 230 medium solar irrigation systems with 3 HP capacity, and 570 small solar irrigation systems with 300W capacity) to replace existing diesel generator irrigation pumps and 5000 biodigester systems and improved stoves for livestock farmers to provide an additional income source (slurry, manure, or fertilizer) and an alternative source of energy. The activity will ensure that the full potential of these technologies is harnessed by (i) developing the understanding and knowledge of farmers, and (ii) fostering the creation of sustainable value chains. In order to enhance the development of supply, the project will organize existing operators into Economic Interest Groups. This will allow them to collaborate and pool their resources to provide tailored and high-quality services to smallholder farmers.

Further information on the key technologies is provided below:

<u>1000 Solar pumps</u>

The average cost of a large solar irrigation system (5 HP Size) in Mali is ~US$ 18,800, the average cost of a medium solar irrigation system (3 HP Size) in Mali is ~US$ 12,000 and the average cost of a small solar irrigation system (300 W Size) in Mali is ~US$ 1,100. The average GHG emissions reduction from the solar pumps (by replacing fossil fuel) is 3.0 tCO2eq per year (extract from concept note).

In EX-ACT we use similar figures for emission reduction (avoided consumption of 1200 l of gasoil per year per moto pump= 3 tCO2).

Figures 1: Solar Pump Specifications

	Large pump (5 HP)	Medium pump (3 HP)	Small pump (300 W)
# of Solar pumps	200	230	570
Volume of Water pumped/hr (cubic meter/hour)	10.2	6.6	2.7
pumped /year (cubic meter/year)	20400	13200	5400
area covered per pump (hectares)	10	5	1
Total ha equipped with drip irrigation	3720		

economie de diesel sur pompes	
0.5	l diesel/ha/heure
10	h/ jour
240	jours/an
1200	l diesel/ pompe /an
3	Tco2/an

5000 biogas units

Figure 2 Forestry Wood saved by biogas plants

Number of biogas plants	5000		5	cattle heads / hh whose manure is used for biogas
Ton of compost per year	6			
wood consumpton /head	574		4,0	tons wood per year per HH
Reduction of wood	80%	reduced wood	16072	tons od wood per year

Assuming every beneficiary household has 7 persons and using official statistics of wood consumed per head in Mali (574[1] kg / year), every family uses 4 tons of wood per year. If we consider that wood consumption will be reduced by 80% by using gas from biogas plants, it is equivalent to a reduction of 3,2 tons of wood X 5000 households, equivalent to 16072 tons of wood consumption reduction every year. Furthermore, the adoption of biogas will reduce the emission of methane and nitrous oxide from manure management for the heads of cattle of biogas owners (assumed 5 heads per HH)

Activity 1.3.2: Improvement of agroforestry practices on private-owned land

This activity seeks to promote the improvement of agroforestry practices from parkland to multi-strata systems on 21,585 Ha of agroforestry land, specifically relating to acacia Senegal and shea trees. The capacities of several stakeholders will be leveraged to ensure the successful implementation of this activity (e.g., nurseries for production and distribution of inputs, farmers for planting, and communities for the management of trees and shared resources). The efficient management of these planted areas by communities will be critical to ensure sustainability after project implementation and avoid conflict, notably between crop and livestock farmers.

Value Chains Targeted by IAAT through Activities 1.1.1 and 2.3.1

Within the project formulation process, in line with regions selected, some specific value chains were prioritized for activity 1.1.1 and 2.3.1 - in line with their current presence and adaptability in targeted regions, their pro-poor growth potential, their climate resilience, and their mitigation potential. These include drought-resilient agroforestry value chains such as Shea and Arabic Gumas well as irrigated productions such as Mango trees, Moringa and vegetables.

Allocation of improved areas per supported value chain

The 21,585 ha of improved agroforestry is going to focus on Shea trees and gum Arabic plantations. The 3,720 ha newly irrigated areas will be allocated to mango, vegetable, and moringa. The land allocation between the three crops is justified by the market absorption capacity of incremental production.

[1] https://www.researchgate.net/publication/277767574_Fuelwood_Consumption_and_Woody_Biomass_Accumulation_in_Mali_West_Africa

Table 2: Land Targeted and Incremental Production by Value Chain

Value chains targeted	Yield (kg)	Part of land for specified intervention	Area (ha)	Incremental Production (T)
Non irrigated				
Shea	60	50%	10793	648
Gum Arabic	180	50%	10793	1943
CSA cereals	700	100%	32378	22664
Irrigated				
Mango trees	16000	54%	2000	32000
Vegetable	15700	15%	570	8949
moringa	23000	31%	1150	26450
Total produced			57683	92653
average yield (t)	*1.606*			

Further contextual detail is provided on each of the above value chains below, provided by the Mali Canada Economic Forum. Further detail on each of the value chains can be found in the Feasibility Study, Annex B: Market, Technology, And Agricultural Value Chains Analysis.

Arabic Gum (Acacia Senegal Tree)

Mali is a significant global supplier of Crude Gum Arabic (CGA) obtained from the sap of Acacia Senegal, also known as the gum arabic tree. The country's gum arabic value chain involves collectors, traders, and exporters who contribute to the production and commercialization of this valuable resource. While Mali has a long history in gum arabic production, challenges and opportunities exist in maximizing its potential.

Gum arabic is a natural product derived from hardened acacia tree sap, harvested in the Sahel region of Africa, gum arabic is used primarily by the food industry. UNCTAD is now spotlighting the huge potential of revenue growth that lies in transforming the commodity into processed export goods in a special gum Arabic-themed issue of its Commodities at a Glance series. Mali offers two varieties of gum which are: hard gum, predominantly from Senegal acacia, and crumbly gum. Gum arabic from Mali is either colorless or yellowish and is characterized by its distinctive tasteless and toxin-free taste. It is available in very large quantities with an undeniable comparative advantage and an unbeatable price.

Table 3: Production of Arabic Gum

Regions	Acacia Senegal- Gum Arabic (MT)
Koulikoro	2306
Sikasso	0
Segou	2104
Mopti	1619
Tombouctou	2479
Gao	9
Bamako	0
Total Mali 2021	11827
Growth 2020-21	9%

With more than 10,000 hectares of plantation adding to natural acacia areas, in Mali, gum arabic is produced in 6 of the 8 regions of the country. The Kayes region is the most important gum-bearing area dominated by acacia-Senegal, acacia-Seyal and combretum are dominant in the other zones.

In Mali, more than 370,500 people make a living from the production of gum arabic, of which 80% (296,400) are women. The industry stakeholders (nurserymen, producers, collectors, processors, traders, and exporters) are grouped together in cooperative societies and unions of cooperative societies[2]. In 2021, national production is estimated to be around 11827 MT subject to an annual increase of 9%. Targeted regions in the table cover over 80% of the production (see table).

In 2019 Mali sold 9,459 tonnes of natural gum arabic. Through 2019 alone, the market for Mali natural gum arabic (agro commodities category) has climbed, recording a change of 51 % compared to the year 2018. Between 2017 and 2019, natural gum arabic's exports increased by 22.67 percent netting the exporter US$3.07m for the year 2019. The export price of Natural Gum Arabic from Mali over the last five years has been quite varied. The retail price range for France natural gum arabic in July is between US$ 2.3 and US$ 5.8 per kilogram.

The transformation of gum arabic production into more income-generating activities can not only promote economic development through higher incomes, but also to secure rural livelihoods, empower vulnerable groups, including women, and promote synergies with natural resource management and climate change mitigation. (source: https://unctad.org/news/gum-arabic-growing-demand-means-new-opportunities-african-producers)

Shea value chain

Shea butter production involves a series of steps, starting with the collection and drying of shea nuts, followed by sorting, cleaning, roasting, grinding, and separating the oil from the solids. The oil is then skimmed, cooled, and filtered to produce shea butter.

2 source: https://forumecomalicanada.com/gum-arabic/

Technological factors affecting the shea value chain include traditional, semi-industrial, and industrial extraction methods, with varying extraction rates and quality.

Mali is the world's second-largest producer of shea nut and accounts for approximately 20 percent of the global supply of shea. Shea butter is used as a cocoa butter equivalent in cosmetics and in the food industry. But a lack of technology and modern industry means that Mali produces virtually no industrial shea butter. Most of Mali's shea nuts are sold raw or processed locally into low-quality artisanal shea butter, keeping the country on the fringes of the lucrative and fast-growing industrial shea butter market. For a conflict-affected country like Mali, where over 42 percent of the population lives in poverty, this is an opportunity lost—especially for the approximately one million mostly poor, rural women who work in Mali's shea value chain. Shea production 2021 is estimated to be around 177000 tons at the national level while targeted regions mostly Koulikoro, Sikasso, Segou cover 98000 Tons (60%). More than 1 millions of rural harvesters in Mali, the majority of whom are women, are involved in shea nuts collection. However, its shea processing industry is not yet modern.

Table 4: Production of Shea Nuts

Regions	Shea Nuts (MT)
Koulikoro	39815
Sikasso	53554
Segou	4986
Mopti	241
Tombouctou	0
Gao	0
Bamako	0
Total Mali 2021	176695
Growth 2020-21	5%

The project will help Mali, a fragile and conflict-affected country, develop a shea processing industry capable to produce and export shea butter, a cocoa butter equivalent, meeting the high-quality demands of the international food and cosmetic industries.

IFC and the Private Sector Window of GAFSP are supporting industry Mali Shi in 2019 to build the country's first active modern shea butter processing plant, increasing incomes for the 120,000 shea producers who supply nuts to the company. the investment will be accompanied by an advisory program that will build the managerial and financial capacity of more than 100 harvesting cooperatives in Mali Shi's supply chain. IFC will also help Mali-Shi improve safety standards, energy efficiency, traceability, and environmental and social management. (source: https://www.gafspfund.org/projects/malis-shea-nut-industry-takes-root)

Mali produced 250,000 tonnes of shea almond, of which 60,883 and 22,908 were exported in 2019 and 2020 respectively. The potential of butter is 135,000 tonnes, of which 97,000 are exploited. Mali can greatly increase the supply to importers of butter, almonds, and products made from shea. Shea is available at all the production sites located in Kayes, Koulikoro, Sikasso, Ségou and Mopti[3].

[3] https://forumecomalicanada.com/shea/

Moringa Value chain

Moringa oleifera is originally a tropical crop with fast development, little known in developed countries but cultivated since ancient times. It can adapt to regions affected by climate change, such as the Mediterranean basin since it is a crop with great resistance to high temperatures.

Moringa is a genus of shrubs and trees with multi-purpose uses: its leaves, roots and immature pods are consumed as vegetables. All parts of the moringa tree – bark, pods, leaves, nuts, seeds, tubers, roots, and flowers – are edible. The leaves are used fresh or dried and ground into powder. The seed pods are picked while still green and eaten fresh or cooked. Moringa seed oil is sweet, non-sticking, non-drying, and resists rancidity, while the cake from seed is used to purify drinking water. The seeds are also eaten green, roasted, powdered, and steeped for tea or used in curries.

For Mali to meet the 2030 Sustainable Development Goals (SDGs) agenda and improve the living standards of the population, it is important to find new directions in scaling up production, processing local raw materials, and exporting worldwide. It is highly valuable to create economic, social, and environmental impacts via the promotion and commercialization of Moringa products with an inclusive value chain including the most vulnerable people, women, and youth. Classified as a "Superfood", Moringa oleifera is a fast-growing, drought, harsh climate, sun- and heat-loving tree that can grow up to 2 m particularly suitable for dryland countries such as Mali. Developing an effective buyer-driven approach with women and young farmers in rural areas, promoting Moringa planting all over the country, and commercializing processed Moringa leaves into tea, powder, and oil, will contribute to creating economic, social, and environmental impacts in Africa region and ensure sustainability by making profits out of the commercialization (source: https://www.actahort.org/members/showpdf?booknrarnr=1348_34)

Moringa trees absorb carbon dioxide 20 times more than other general trees, which means a mature Moringa tree can absorb around 80 kg of carbon per year, making it an effective tool to combat the effects of climate change. Another great benefit is the fact that Moringa can be used to combat malnutrition, especially among infants and nursing mothers," Rokiatou adds. "It provides a versatile, nutritious food source with high levels of proteins, vitamins and calcium throughout the year."

Mango value chain

Mali, specifically the country's southern region, is among the largest mango producers in West Africa and among the fastest growing mango exporters in the world. In 2015, Mali produced 600,000 tons of mangoes, contributing to $30 million in exports. But, of all the mangoes grown and produced in 2015, the country's mango industry exported only 6 percent. Despite high production levels, post-harvest losses and limited market access result in a small portion of the mangoes being sold. The mango market in Mali is segmented among traders supplying different varieties, with Amélie being replaced by Kent and Keitt due to better shelf life and customer preferences.

Producers of mango in Mali are mainly smallholder farmers who have diversified crops. Mango is an important source of income for them as it grows during the dry off-season. Traditional plantations, with an average size of 2 to 3 hectares and around 200 trees per hectare, are the most common method of production. The region of Sikasso, which shares borders with Burkina Faso and Ivory Coast, is the main mango production area in Mali. In 2019, Sikasso region accounted for 69% of the national production (58,000 tonnes), followed by Koulikoro with 19% (16,500 tonnes) and the Bamako region with 9% (8,300 tonnes).

The agro-ecology and the relatively low cost of labour required by mango enterprises provide the country with a comparative advantage in mango production. This advantage is not effectively used by different actors in the mango value chain. This is due to lack of appropriate infrastructure and competencies to overcome the technical, commercial, financial, and legal challenges that should be overcome in order to develop a viable activity[4]

Mali is a global exporter of mangoes with an estimated annual export of 22,276 tonnes, 31,277 tonnes and 22,011 tonnes in 2018, 2019 and 2020. Mali has more than thirty years of mango export experience and has professional exporters grouped into associations, federations and EIGs operating in the fields of fruit and vegetable exports, concentrating on mangoes. The main export market for Mali is Europe.

In Mali, there are around 87 varieties of mangoes, of which only a few, in sufficient quantity, are exportable to international markets. Mango production season begins very early in March with early varieties (i.e., Zill, Irwin), continuing until August with semi-late varieties (i.e., Amélie, Valencia, Haden) and late varieties (i.e., Kent, Keitt). All varieties have very high production potential, supported by good climatic conditions. Because of the importance of mangoes in Mali, producers apply irrigation during dry season to promote their growth. Irrigation, combined with organic manure application, ensures good flowering, reduces the production cycle, increases fruit density, and improves fruit quality. Survey results in Mali have shown that 79 percent of mango producers irrigate their crops; only 21 percent rely entirely on rainfall.

Vegetable value chain

In Mali, the vegetable sector has enormous potential. Despite this potential, local production is still dominated by major constraints that make it unproductive and uncompetitive in the local and sub-regional market. Poor agricultural practices among farmers, poor market organization, climate change, inadequate access to water, weak means of production, and the high rate of post-harvest losses due mainly to the excessive use of chemical inputs (fertilizers, pesticides) are the main causes. These challenges constitute a real risk to the health of Malian consumers and a considerable loss of income for the actors in the vegetable value chain.

Activity 1.2.1: Build awareness, capacity, community interest and field-level adoption of CSA techniques and agroforestry amongst smallholder farmer communities (crop and/or livestock). In addition, the CSA package provided by the IAAT project include use of compost, irrigation, improved seeds, crop rotation, reduced tillage, and biopesticides. Activity 1.2.1 will cover 64,755 farming households (75% of 86,340 farming households-direct beneficiaries) that will adopt these CSA practices supported by GCF fund. This involves the adoption of Climate-Smart Agriculture (CSA) techniques in 21,585 ha of land used for cereal crop cultivation. CSA techniques use of GHG calculation include improved agronomic practices (improved

[4] https://www.researchgate.net/publication/323218678_Innovation_Opportunities_in_Mango_production_in_Mali

varieties, crop rotation and use of crop residues), nutrient management (improve N use efficiency), adoption of reduced tillage, improved irrigation measures, and manure application. The GHG reduction from the adoption of CSA technologies/practices with GCF fund support will be direct contribution.

EX-ANTE GHG IMPACT AND CARBON BALANCE APPRAISAL OF IAAT

GHG analysis methodology and overview of the EX-ACT tool

Use of Life cycle analysis and carbon footprint in environment appraisal

Sustainability and the concept of life cycle assessment

The 1980s and 1990s witnessed rising public awareness of environmental issues. This evolution was reflected at the 1992 United Nations Conference on the Environment and Development in Rio de Janeiro, when governments recognized the importance of good stewardship of natural resources in achieving sustainable development. As consumers have become increasingly sensitive to environmental issues, the intensive mode of agricultural production has attracted growing attention[5].

Agriculture, forestry, and other types of land use are responsible for up to 25% of anthropogenic GHG emissions (Smith et al. 2014). Today agriculture and the food system are at a meeting point, facing the challenge of increasing food production by more than 60% by 2050 (FAO 2013) without intensifying damage to the environment. Currently, food production responds to basic needs and to numerous social, cultural, and aesthetic needs and demands (Notarnicola et al. 2016). The requirement to feed seven billion people and address dietary changes necessitate the intensification of production, while environmental threats such as desertification, drought soil degradation, loss of freshwater, and biodiversity add to and exacerbate the list of challenges that humanity has to face. Climate change (CC) is also one of the greatest challenges to the agriculture sector, putting at risk food production, food security, and livelihoods.

In this context, improving food production and consumption systems and reducing food waste and loss, which represent a third of the production (FAO 2011), are of prime importance for ensuring sustainable development from both environmental and socio-economic perspectives at a local or global scale (Notarnicola et al. 2015). Hence, strategic objectives for ensuring food safety, reducing rural poverty, and developing a sustainable and conservative agroecosystem are becoming increasingly important in the debate of decision-makers. Recent studies have suggested a research agenda for food sustainability. For example, Soussana (2014), who specifically addressed the European context, prioritized the production side: i) the sustainable intensification of European agriculture, ii) the operationalization of agriculture within limits for GHGs, energy, biodiversity, and contaminants, and iii) the improvement of resilience to CC in agricultural and food system[6]

Life Cycle Assessment (LCA) is a technique for assessing the potential environmental aspects and potential aspects associated with a product (or service),

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[5] *Liu 2008; Lescot 2012; Craig et al. 2012; Notarnicola et al. 2015*

[6] *(PDF) Life cycle analysis and the carbon footprint of coffee value chains*. Available from: https://www.researchgate.net/publication/322275158_Life_cycle_analysis_and_the_carbon_footprint_of_coffee_value_chains [accessed Mar 24 2023].

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). It 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 may be used to identify opportunities to improve the environmental performance of products, inform decision-making, and support marketing, communication, and awareness-building efforts.

Carbon footprint appraisal

The LCA-based carbon footprint (CFP) of a product is the number 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 considered as shown in Figure 1 – 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).

Worldwide, standards and methodological frameworks and tools have been developed in recent years in the context of CFP for the agriculture sector. They aim to identify, measure, reduce, and mitigate the emissions of products, events, companies, and territories (ITC 2012). The United Kingdom and France have been proactive with, respectively, (i) the Publicly Available Standard 2050 (PAS 2050), among the first public product carbon methodologies from the British Standard Institute (BSI) and the Department for Environment Food and Rural Affairs (DEFRA) and (ii) the Bilan Carbone, a GHG assessment tool developed by the French Agency for Environment and Energy Management (ADEME). Besides there are also international standards of carbon accounting, including the GHG Protocol, widely used by government and business leaders to understand, quantify and manage GHG emissions (Protocol GHG 2017), and also GHG accounting tools that are more integrated and designed to facilitate the whole GHG computation within the different steps of a food value chain or the life cycle such as EX-ACT tool and the Cool Farm Tool.

Introduction to EX-ACT tool

The Ex-Ante Carbon-balance Tool (EX-ACT) is an appraisal system developed by FAO providing ex-ante estimates of the impact of agriculture and forestry development projects, programmes, and policies on the carbon balance. The carbon balance is defined as the net balance from all GHGs expressed in CO2 equivalents that were emitted or sequestered due to project implementation as compared to a business-as-usual scenario. EX-ACT is a land-based accounting system, estimating C stock changes (i.e. emissions or sinks of CO2) as well as GHG emissions per unit of land, expressed in equivalent tonnes of CO2 per hectare and year. The tool helps project designers to estimate and prioritize project activities with high benefits in economic and climate change mitigation terms. The amount of GHG mitigation may also be used as part of economic analysis as well as for the application for funding additional project components. The tool can be applied to a wide range of development projects from all AFOLU sub-sectors, including other projects on climate change mitigation, watershed development, production intensification, food security, livestock, forest management, or land use change. Further, it is cost-effective, requires a compared small amount of data, and has resources (tables, maps) that can help find the required information. While EX-ACT is mostly used at the project level it may easily be upscaled to the programme/sector level and can also be used for policy analysis.

EX-ACT can be applied to calculate the mitigation potential of any type of land use-based intervention, either public or private. It can be used to evaluate projects, policies as well as national level programmes. The results allow the decision makers to ensure that all the interventions contribute to meeting climate change mitigation goals, such as those expressed in the Nationally Determined Contributions, while continuing progress towards other environmental and socioeconomic objectives, either at regional, national, or international levels, for example climate change adaptation goals expressed in National Adaptation Plans or Sustainable Development Goals.

Although the EX-ACT appraisals were initially designed for ex-ante analysis, the tool can be successfully applied during the project implementation as well as ex-post for comprehensive monitoring and evaluation, both at a project and at a country level. The current version of EX-ACT is primarily based on the Intergovernmental Panel on Climate Change (IPCC) 2019 Refinement to the 2006 Guidelines for National Greenhouse Gas Inventories (IPCC, 2019) and IPCC 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands (IPCC, 2014), complemented by another scientific research. GHG fluxes from farm operations, inputs, transport, and irrigation systems implementation are based on Lal (2004). Emission Factors for electricity use are based on United Nations Framework Convention on Climate Change (UNFCCC, 2021). Emission factors for the fishery sector are derived from Parker and Tyedmers (2015), Winther et al. (2009), and Irribaren et al. (2010 and 2011). Soil carbon stock in mangroves is complemented by the review from Atwood et al. (2017).

EX-ACT methodological framework

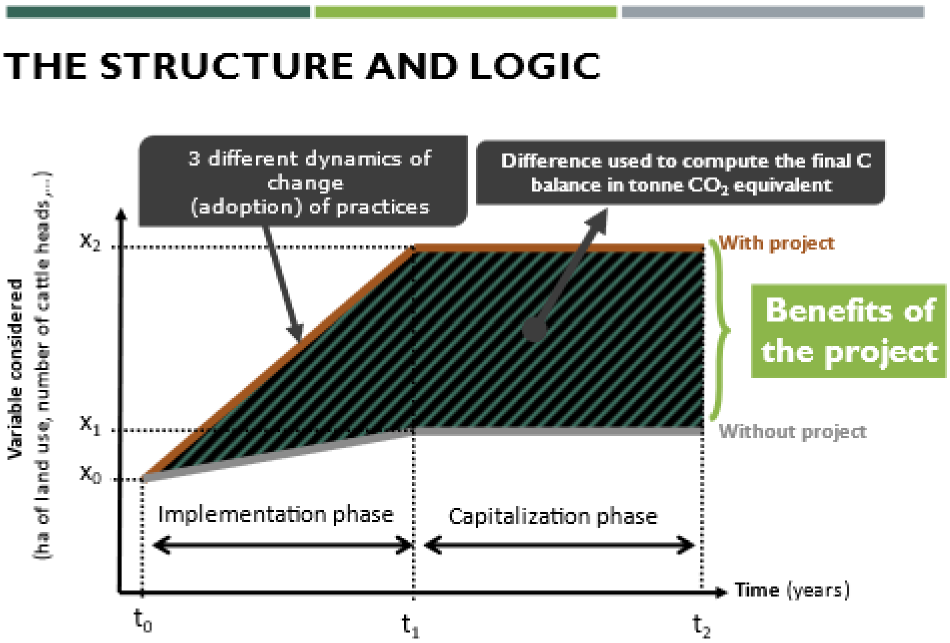
The scope

EX-ACT is a land-use-based accounting system, that measures emissions and carbon stock changes per unit of land (in hectare), expressed in tonne of carbon dioxide equivalent (tCO2-e) per ha and per year (tCO2-e/ha/yr). It covers the whole agricultural sector including the agriculture, forestry, and other land use (AFOLU) sector, fisheries and aquaculture, agricultural inputs, and infrastructure. The AFOLU activities included covering land use changes (deforestation, afforestation/reforestation, and other land use change) and land management (annual crops, perennial crops, flooded rice, grasslands, and livestock breeding), as well as inland and coastal wetlands. Agricultural inputs covered in the tool include fertilizers, pesticides, use of machinery, use of irrigation, and alike, while infrastructure includes the construction of irrigation systems, on-farm buildings, and feeder roads. EX-ACT consists of a set of linked Microsoft Excel sheets into which the user inserts basic data on agricultural activities and practices.

The underlying concepts

The analysis is conducted by comparing two scenarios: a situation when an intervention, for example, a project, is implemented and a baseline situation that would prevail in the absence of the project (also referred to as “reference scenario”). The comparison between the GHG emissions and carbon stock changes resulting from the implemented project and those that would occur in the baseline (without the project) gives the final carbon balance reported in EX-ACT. The tool distinguishes two periods of time-related to the project: the implementation phase (i.e. the active phase of the project when activities are being implemented) and the capitalization phase (i.e. a period where emissions and carbon stock changes continue to occur as a result of the implemented activities).

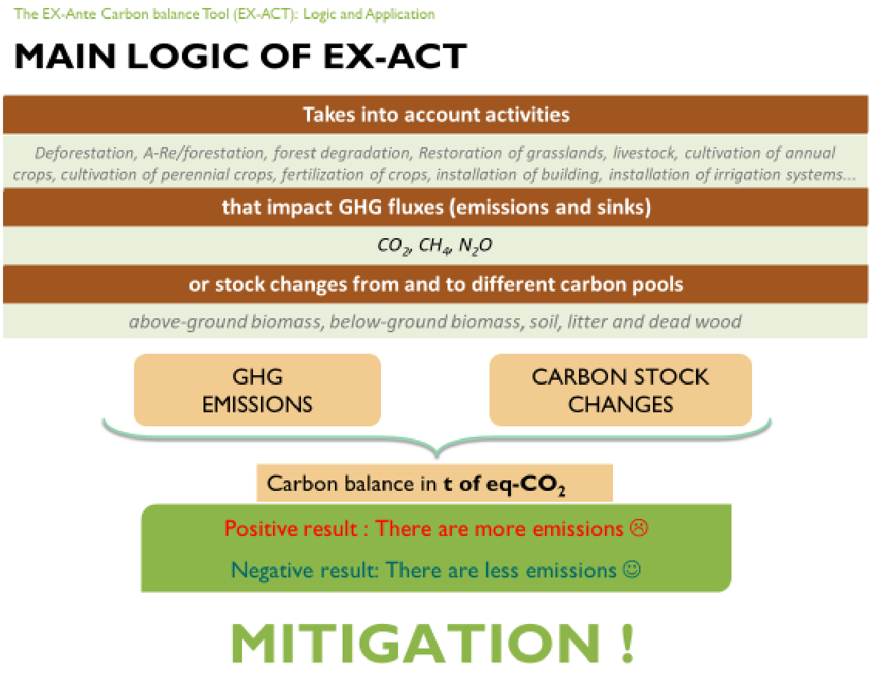
Figure 3: Structure of the model



The Figure presents a simplified example of how the carbon balance is calculated in EX-ACT using an afforestation project. In a reference scenario, without a project, only a small portion of land will be afforested (grey line). The project activities foresee afforestation at a larger scale (yellow line). Afforestation activities will occur in the period from t0 to t1 (implementation phase), yet the carbon will continue to be sequestered until t2 is reached (the capitalization phase). The overall benefits of the afforestation project can be calculated as the difference between with project and reference scenario, represented in the figure by the shaded area.

The carbon balance is an incremental balance gathering GHG emissions and carbon stock changes from all components of the AFOLU sector. GHG emissions considered are CO2, CH4, and N2O all accounted in Equivalent CO2 emissions using their Global Warming Potential (GWP) provided by IPCC.

Figure 4: Logic of the Model



Data used in the EX-ACT model for the GHG analysis.

Baseline IPCC Values

EX-ACT tool includes a wide series of over 8000 IPCC default values including LCA-based carbon footprints for all agriculture inputs (fertilizer, pesticides), energy (diesel, electricity, gas…), investments (CFP per m2 of building, road, per ha of irrigation equipment) as shown below:

Figure 5: Coefficients of emissions of GHG for inputs

Use this part only if you want to refine the analysis with Tier 2 coefficients.
(default values are provided for your information only, while EX-ACT will use Tier 2 values automatically wherever specified)

Emission factors	**Emissions at field level**						**Emissions from production, transportation, storage and transfer**		
	CO2 emissions			N2O emissions					
Lime application	Unit	Default	Tier 2	Unit	Default	Tier 2	Unit	Default	Tier 2
Limestone (tonnes per year)	tC/t lime	0,12					tCO2/t CaCO3	0,59	
Dolomite tonnes per year)	tC/t lime	0,13					tCO2/t CaCO3	0,59	
not-specified (tonnes per year)	tC/t lime	0,125					tCO2/t CaCO3	0,59	
Fertilizers									
Urea (tonnes of N per year - Urea has 46.7% of N)	tC/t Urea	0,2		kg N-N2O/kg N	0,01		tCO2/t N	4,77	
Other N-fertilizers (tonnes of N per year)				kg N-N2O/kg N	0,01		tCO2/t N	4,77	
N-fertilizer in irrigated rice (tonnes of N per year)				kg N-N2O/kg N	0,003		tCO2/t N	4,77	
Sewage (tonnes of N per year)				kg N-N2O/kg N	0,01				
Compost (tonnes of N per year)				kg N-N2O/kg N	0,01				
Phosphorus (tonnes of P2O5 per year)							tCO2/t P2O5	0,73	
Potassium (tonnes of K2O per year)							tCO2/t K2O	0,55	
Pesticides									
Herbicides (tonnes of active ingredient per year)							tCO2/t active ingredient	23,1	
Insecticides (tonnes of active ingredient per year)							tCO2/t active ingredient	18,7	
Fungicides (tonnes of active ingredient per year)							tCO2/t active ingredient	14,3	

Urea CO2 removal from the atmosphere during urea manufacturing is estimated in the Industrial Processes and Product Use Sector by the country where urea was produced.
By default EX-ACT considers that urea is imported and do not account for this sink, but you can force the calculation to do so: **Account the manufacturing sink?** NO

Figure 6: Coefficients of emissions of GHG for energy

	Unit	Default	Tier 2
Electricity (MWh per year)			
Emission factor for the selected country	$tCO_2/MWh/yr$	0,431	
Losses of electricity during transportation	%	10	
User defined (Tier 2):	$tCO_2/MWh/yr$		
Losses of electricity during transportation	%	10	
Liquide or gaseous (in m3 per year)			
Gasoil/Diesel	$t\ CO_2/m^3$	2,62	
Gasoline	$t\ CO_2/m^3$	2,92	
Gas (LPG/ natural)	$t\ CO_2/m^3$	0,00	
Butane	$t\ CO_2/m^3$	0,01	
Propane	$t\ CO_2/m^3$	0,01	
Ethanol	$t\ CO_2/m^3$	0,52	
	$t\ CO_2/m^3$		
Solid (in tonnes of dry matter per year)			
Wood	$t\ CO_2/t$ dry matter	0,24	
Peat	$t\ CO_2/t$ dry matter	0,003	

Figure 7: Coefficients of emissions of GHG for infrastructure

7.3. Construction of new infrastructure (irrigation systems, buildings, roads)

Back

Use this part only if you want to refine the analysis with Tier 2 coefficients.

(default values are provided for your information only, while EX-ACT will use Tier 2 values automaticall

Emission factors

	Unit	Default	Tier 2
Irrigation systems			
Hand moved sprinkle	$kgCO_2/ha$	59,8	
Please select	$kgCO_2/ha$	0,0	
Please select	$kgCO_2/ha$	0,0	
Buildings and roads			
Housing (concrete)	$t\ CO_2/m^2$	0,436	
Agricultural Buildings (concrete)	$t\ CO_2/m^2$	0,656	
Industrial Buildings (concrete)	$t\ CO_2/m^2$	0,825	
Garage (concrete)	$t\ CO_2/m^2$	0,656	
Offices (concrete)	$t\ CO_2/m^2$	0,469	
Please select	$t\ CO_2/m^2$	0	
Please select	$t\ CO_2/m^2$	0	

Data selected in EX-ACT modules for IAAT Carbon Balance Analysis

Definition of climate, type of soil, project duration

Figure 8: Context used in Ex-ACT model

Project Name	GCF Save the Children MALI Project	
Continent	Africa	
Climate	Tropical	
Moisture regime	Dry	
Dominant Regional Soil Type	Sandy Soils	
Duration of the Project (Years)	Implementation phase	5
	Capitalisation phase	10
	Duration of accounting	**15**

The continent, climate, moisture regime, and dominant soil type are key data allowing the EX-ACT tool to select the appropriate IPCC coefficients. As usual, the present carbon balance analysis is done over 15 years including 5 years of project implementation phase and 10 years of capitalization. Such duration is in line with the time required for Carbon stabilization in the soil after land use change and perennial tree biomass growth.

Land use change induced by the project

The land use change is mostly from set aside to perennials. The EX-ACT printout below illustrates how the data is entered in EX-ACT. It covers only a small portion of the land improved by the project and excludes vegetable areas and improved agroforestry which are not subject to land use changes.

Figure 9: Land Use Changes used in EX-ACT model

2.3. Other Land Use Changes

Fill with your description	Initial land use		Final land use	Message	Fire Use? (y/n)	Area transformed (ha) Without	*	With	*
	Degraded Land	→	Perennial/Tree Crop		NO	0	D	0	I
	Set Aside	→	Perennial/Tree Crop		NO	0	D	0	I
	Grassland	→	Perennial/Tree Crop		NO	0	D	0	I
	Annual Crop	→	Perennial/Tree Crop		NO	0	D	0	I
	Set Aside	→	Perennial/Tree Crop		NO	0	D	3,150	D
	Select Initial Land Use	→	Perennial/Tree Crop	Fill initial LU	NO	0	D	0	D
	Select Initial Land Use	→	Select Final Land Use	Fill initial LU	NO	0	D	0	D
	Select Initial Land Use	→	Select Final Land Use	Fill initial LU	NO	0	D	0	D
	Select Initial Land Use	→	Select Final Land Use	Fill initial LU	NO	0	D	0	D
	Select Initial Land Use	→	Select Final Land Use	Fill initial LU	NO	0	D	0	D

Energy consumed without and with project

Figure 10: Energy consumption inputs in Ex-ACT model

7.2. Energy consumption (electricity, fuel,...)

Description and unit to report	Quantity consumed per year				
	Start	Without	*	With	*
Electricity (MWh per year)					
Other Africa	0	0	D	0	D
User defined (Tier 2):	0	0	D	0	D
Liquide or gaseous (in m3 per year)					
Gasoil/Diesel			D	52	I
Gasoline	1,250	1,250	D	0	D
Gas (LPG/ natural)	0	0	D	0	D
Butane	0	0	D	0	D
Propane	0	0	D	0	D
Ethanol	0	0	D	0	D
User defined (Tier 2): 0	0	0	D	0	D
Solid (in tonnes of dry matter per year)					
Wood	16,072	16,072	D	0	D

This accounts for the volume of wood (16072 tonnes of dry matter per year) consumed without the project by households which will be avoided with the project by the use of biogas units (-5137 tCO_2 per year) and the reduction of gasoline consumption (1250 m3/year) by replacing gasoline pumps with solar pumps (-3634 tCO_2 per year)

Land use evolution on the project

Figure 11: Land use evolution in HA in Ex-ACT model

3.2.1. Perennial systems from other LU or converted to other LU (please fill step 2.LUC previously)

Description	Residue/ biomass burning	Yield (t/ha/yr) ?	Area (ha)		
			Start	Without	With
Perennial after Deforestation	NO		0	0	0
Converted to A/R	NO		0	0	0
Perennial after non-forest LU	NO	1.606266199	0	0	3,150
Converted to OLUC	NO		0	0	0

3.2.2. Perennial systems remaining perrenial systems (total area must remain constant)

Fill with your description	Agroforestry systems ?	Residue/ biomass burning	Yield (t/ha/yr) ?	Area (ha)			
				Start	Without	*	With
Agroforestry without project	Parkland	NO		21,585	21,585	D	0
Improved agroforestry with project	Multistrata systems	NO			0	D	21,585
	Please select system	NO		0	0	D	
	Hedgerow	NO		0	0	D	0
	Multistrata systems	NO		0	0	D	0
	Parkland	NO		0	0	D	0
	Shaded perennial-crop systems	NO		0	0	D	0
	Silvopastures	NO		0	0	D	0
	Please select system	NO		0	0	D	0
	Please select system	NO		0	0	D	0

Evolutions of land use / category (hectares - ha)

		Initial State	Without project	With project
Forest/Plantation		0	0	0
Agriculture	Annual	32,948	32,948	32,948
	Perennial	21,585	21,585	24,735
	Rice	0	0	0
Grassland		0	0	0
Other lands	Degraded	0	0	0
	Other	3,150	3,150	0
Wetlands		0	0	0
Total area (ha)		57,683	57,683	57,683

Global warming coefficients used

EX-ACT provides different options for Global warming coefficients. This analysis was done with the Last Update for GWP100 (IPCC-2013)

Figure 12: Global Warming Coefficient Utilised

Select GWP for calculation	
Last Update for GWP100 (IPCC-2013)	
CO_2	**1**
CH_4	**34**
N_2O	**298**

EX-Ante GHG Impact of GCF IAAT Project

Carbon Balance of GCF IAAT project

All calculations done in the EX-ACT tool are reported in the results module (below). After a short reminder of the description module (name of the appraised project, its duration, the continent, the dominant climate, and the soil chosen by the user) including the total area of the project, the following table (see Figure 14) summarize the GHG sequestration and the share of the balance per GHG from the adopted scenario. The balance is the difference in GHG gross fluxes between the “with project” situation and the “without project” situation. Results are given in tonne CO2 equivalent (tCO2-e). Positive numbers represent sources of CO2-e emission while negative numbers represent sinks. The left table section summarizes estimated gross fluxes and CO2-e emissions and sinks from the scenario without-project (left column), from the scenario with-project (middle column), and the total balance (right column). The middle table details the Carbon Balance under project implementation, showing the GHG fluxes from the different modules. Provided in the annex, the right table details annual CO2-e fluxes for the different activities without and with project implementation, and for the carbon balance.

The carbon balance (C Balance) of the project which consists of the difference of tCO2-eq emitted or sequestered between a scenario with the project and a scenario business-as-usual (BAU or baseline scenario) demonstrates the benefits of implementing the project and its different components in terms of mitigation potential. This project covers 15 years in EX-ACT (5 years of implementation and 10 years of capitalization).

In 15 years, this project will fix a carbon balance estimated at 2.45 million tCO2e, which is equivalent to 163,103 tCO2 fixed per year. Such impact is computed on a wide range of activities, outputs, and consumptions generated by the project within an incremental approach which requires assessing both “without project” and “with the project” situation (detailed above) and computing a balance of “with” situation minus “without” situation. The main source of carbon fixing is agroforestry and CSA cereals which will fix 2.31 million tCO2. When combined with the solar energy and biogas impact the total impact is around 2.45 million tCO2e of carbon sequestration.

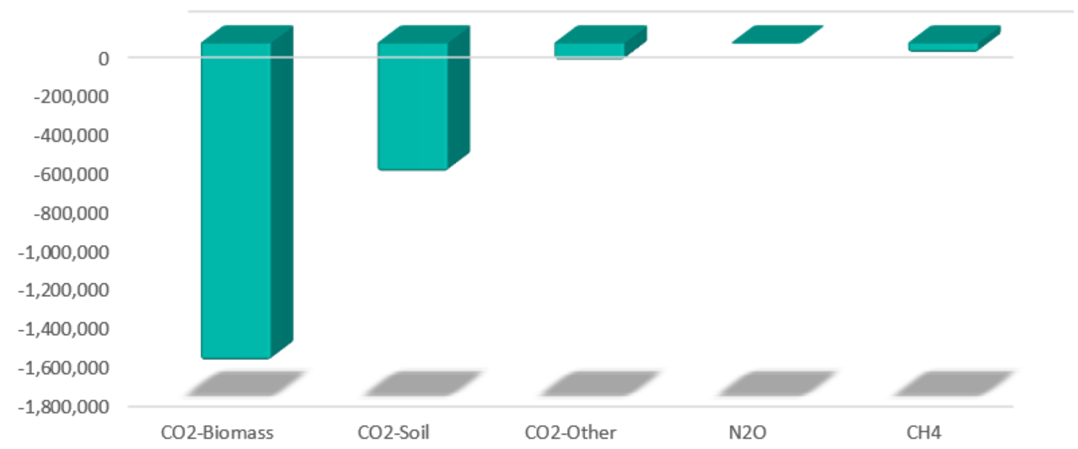
Figure 13: Ex-ACT model summary of IAAT

Project Name	GCF Save the Children MALI	Climate	Tropical (Dry)	Duration of the
Continent	Africa	Dominant Regional Soil Type	Sandy Soils	To

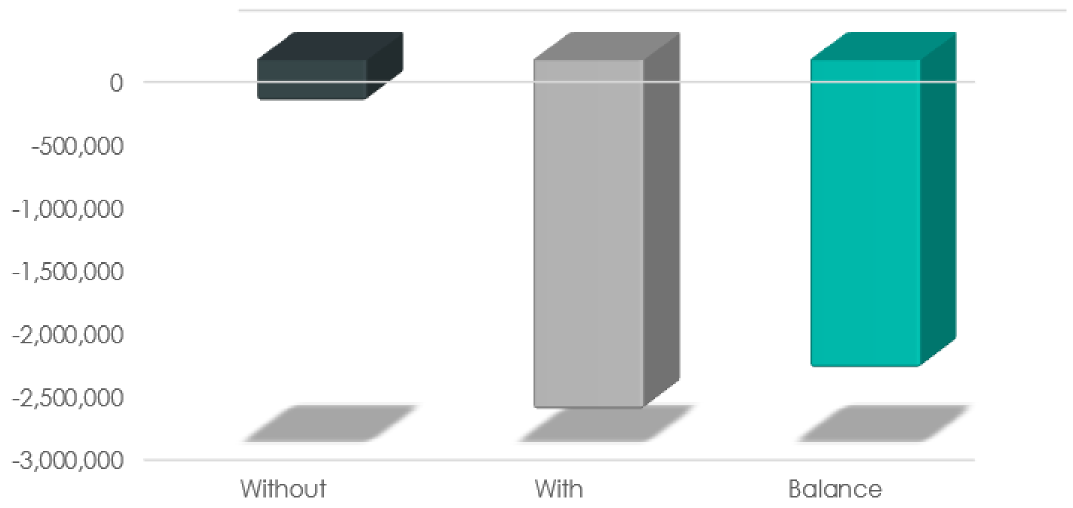
Components of the project	Gross fluxes Without	With	Balance	Share per GHG of the Balance All GHG in tCO2eq CO_2 Biomass	Soil	Other	N_2O	CH_4
	All GHG in tCO2eq Positive = source / negative = sink							
Land use changes								
Deforestation	0	0	0	0	0		0	0
Afforestation	0	0	0	0	0		0	0
Other LUC	0	7,577	7,577	25,479	-17,903		0	0
Agriculture								
Annual	71,917	-622,253	-694,170	0	-634,239		-11,097	-48,834
Perennial	-1,056,586	-2,733,041	-1,676,455	-1,663,462	-12,994		0	0
Rice	0	0	0	0	0		0	0
Grassland & Livestocks								
Grassland	0	0	0	0	0		0	0
Livestocks	544,225	514,840	-29,385				-26,197	-3,188
Degradation & Management								
Forest degradation	0	0	0	0	0		0	0
Peat extraction	0	0	0		0		0	0
Drainage organic soil	0	0	0		0		0	0
Rewetting organic soil	0	0	0		0		0	0
Fire organic soil	0	0	0	0				0
Coastal wetlands	0	0	0	0	0		0	0
Inputs & Investments	111,907	57,797	-54,110			-90,987	36,878	0
Fishery & Aquaculture	0	0	0			0	0	0
Total	-328,537	-2,775,080	-2,446,543	-1,637,982	-665,136	-90,987	-416	-52,022
Per hectare	-5.7	-48.1	-42.4	-30.0	-11.5	-1.6	0.0	-0.9
Per hectare per year	-0.4	-3.2	-2.8	-2.0	-0.8	-0.1	0.0	-0.1

Figure 14 and 16: Carbon Balance from EX-ACT model

Share of the balance per GHG (plus origin for CO2)



Total without and with project and balance



GHG Results per project sub- component

The project includes four main areas of interventions which drive the impact of the project in terms of carbon balance and Climate mitigation. The GHG mitigation impact of the project estimated at 163,103 tCO2e per year is shared between these components as follows.

Figure 15: GHG Carbon Balance by Project Component, overall and per HH/year

	per year		on 15 years	
Total GHG carbon balance ofGCF Save the Children Project	-163,103	TCO2e per year	-2,446,543	TCO2e
GHG impact of Agroforestry component (shea, gum)	-111,244	TCO2e per year	-1,668,656	TCO2e
GHG impact of solar energy pumps and irrigated crops	-3,634	TCO2e per year	-54,512	TCO2e
GHG impact of biogas units and reduced wood consumption	-5,137	TCO2e per year	-77,054	TCO2e
GHG impact of CSA cereals	-43,088	TCO2e per year	-646,320	TCO2e

	Nb HH	GHG impact/HH/ year
GHG impact of Agroforestry component	86340	-1.29
GHG impact of solar energy pumps and irrigated crops	7632	-0.48
GHG impact of biogas units and reduced wood consumption	5000	-1.03
GHG impact of CSA cereals	64755	-0.67
Total	163727	-1.00

<u>Sub-comp: Agroforestry</u>: The main one is the improvement of agroforestry on 21,585 ha of private land for 86,340 farmers (0.25 ha of area of agroforestry per farmer). This activity accounts for the improvement of agroforestry practices from parkland (intercropping of agricultural crops or grazing land under low density mature scattered trees that is typical of dry areas like Sahel) to multi-strata systems (multistorey combinations of a large number of various trees and perennial and annual crops, including home gardens and agroforests). At the household level, this component does allow to fix 1.29 tCO2 per year.

<u>Sub-comp: Solar energy pumps and irrigated crops</u>: In this component, the switch to solar pumps does allow to reduce/avoid the consumption of gasoil of the traditional water pump. This covers the installation of 1000 solar pumps to irrigate 3720 ha of land, which covers 570 ha of Vegetable, 2000 ha of mango trees and 1150 ha of Moringa trees in total. At the household level, it does fix 0.48 tC02e per year.

<u>Sub-comp: Biogas Units to reduce wood consumption</u>: The 5000 biogas units which will be installed will allow a wide reduction of wood consumption among beneficiaries and the incremental production of biofertilizers. The manure used for biogas units (5 cattle heads per unit) is also included in GHG accounting. At the household level, this action does fix over 1.03 tCO2 per year.

<u>Sub-comp: CSA cereals</u>: This involves the adoption of CSA techniques in 32,378 ha of land used for cereal crop cultivation. At the household level, this component does allow to fix 0.67 tCO2 per year.

<u>Carbon footprint</u>

The carbon footprint per ton of agriculture output produced by the project is -2.00 tCO2 fixed per ton of produced output. The negative sign means there is no additional emission of CO2 but a reduction of emission of CO2 due to the CO2 sequestered within the plantation and production process.

Figure 17: Carbon footprint per ton of incremental perennial/ agricultural production

Carbon foot print per ton of incremental perennial/agric production		
Annual GHG emissions	-185,005	
incremental production	92,653	
Carbon Footprint per ton	- 2.00	

Such a negative carbon footprint underlines the characteristics of incremental project food production which is produced within a process of wide expansion of agroforestry and an effort of reduced use of fossil energy and fossil-based inputs both through solar pumping and new biogas units.

MONITORING, REPORTING AND VERIFICATION OF GHG EMISSIONS

The IAAT will collect field-level data on various components of the project, including the area and number of trees (by species) covered under improved agroforestry systems for each direct beneficiary. Additionally, data will be gathered on the number, size, and operational details of installed solar irrigation pumps and biodigesters. Information on the area under Climate-Smart Agriculture (CSA) technologies and practices will also be recorded, categorized by the type of CSA practice. IAAT field staff will conduct these data collection activities on a quarterly basis and maintain a comprehensive dataset to facilitate emissions estimation using the EX-ACT tool. The project will also explore more efficient tools as they become available. Emissions estimation will be outsourcing to the MRV credited organizations that will be selected during the project implementation. The M&E budget will cover this emissions estimation activity.

The IAAT will adopt the UNFCCC's Clean Development Mechanism (CDM) methodology for the monitoring, reporting, and verification (MRV) of greenhouse gas (GHG) emission reductions achieved through the implementation of solar and biodigester systems.
For solar irrigation systems, the AMS-I.A. methodology ("Electricity generation by the user") will be applied. This methodology accounts for the displacement of fossil fuel-based water pumping systems with renewable energy technologies. IAAT will gather key data, including:

- Number and capacity of solar energy-based pumps installed by individual farmers or farmer groups.
- Cost of fossil fuels used for operating equivalent conventional irrigation pumps.
- Volume and cost of fossil fuels required to operate such pumps.
- Actual costs of solar irrigation pump systems compared to fossil fuel-based irrigation systems.
- Area covered by solar-powered pumps versus fossil fuel-powered pumps.
- Weekly and monthly operating hours of solar pumps.

IAAT will monitor the operation of solar pumps on a **quarterly basis**. The process will include:

- Verifying farmers' data logs, which detail hours of operation and area coverage.

- Conducting field checks to ensure accuracy and consistency of reported data.

This approach will ensure comprehensive and reliable measurement of GHG emission reductions and contribute to the accountability and sustainability of the renewable energy systems deployed.

IAAT will utilize the AMS-I.C. methodology for thermal energy production with or without electricity to assess and quantify the greenhouse gas (GHG) emissions reduction achieved through the installation and operation of biodigester systems. This approach will focus on the displacement of fossil fuels (e.g., cooking gas) or traditional biomass (e.g., firewood or charcoal) commonly used for cooking.
<u>Key Activities and Data Collection:</u>

1. Baseline Emissions Displacement:
    a. Determine the baseline energy source (fossil fuels, firewood, or charcoal) used for cooking prior to the installation of the biodigester systems.
    b. Estimate GHG emissions reductions by quantifying the avoided emissions resulting from the replacement of these energy sources with biogas produced by the biodigesters.
2. Data Collection:
    a. Collect detailed data on the amount of cooking gas, firewood, or charcoal replaced by biogas usage.
    b. Record the cost of biodigester installation, operation, and maintenance to evaluate economic impacts.
3. Monitoring and Verification:
    a. Establish a robust monitoring system to ensure the continuous operation of the biodigesters.
    b. Verify data regularly through site visits and audits of farmers' data logs, which will include:
        i. Hours of biodigester operation.
        ii. Amount of gas generated by each biodigester.
    c. Farmer Data Book: Farmers using biodigesters will maintain a logbook to record: i) Daily operation hours of the biodigester. and ii) Volume of biogas generated and utilized.

Regular Inspections: IAAT will conduct periodic field visits to monitor the physical condition and performance of the biodigesters. This will include verification of recorded data and technical checks to ensure system functionality. By integrating AMS-I.C. methodology with systematic data collection and monitoring, IAAT aims to provide a reliable framework for quantifying GHG emissions reductions, supporting sustainable energy practices, and delivering measurable environmental and economic benefits.

CONCLUSION

In 15 years, this project will fix a carbon balance estimated at over 2.45 million tCO2e, which is equivalent to 163,103 tCO2 fixed per year. Such impact is computed on a wide range of activities, outputs, and consumptions generated by the project within an incremental approach which requires assessing both without the project and with the project situation (detailed above) and computing a balance of with situation minus without situation. The main source of carbon fixing is agroforestry and

CSA cereals which will fix 2.31 million tCO2. When combined with the biogas and solar irrigation impact it totals around 2.45 million tCO2e of carbon sequestration.

Figure 18: Overall GHG Appraisal

Project Name	GCF Save the Children MAI		Climate
Continent	Africa		Dominant Regional Soil Type

Components of the project	Gross fluxes Without	With	Balance
	All GHG in tCO2eq		
Land use changes	Positive = source / negative = sink		
Deforestation	0	0	**0**
Afforestation	0	0	**0**
Other LUC	0	7,577	**7,577**
Agriculture			
Annual	71,917	-622,253	**-694,170**
Perennial	-1,056,586	-2,733,041	**-1,676,455**
Rice	0	0	**0**
Grassland & Livestocks			
Grassland	0	0	**0**
Livestocks	544,225	514,840	**-29,385**
Degradation & Management			
Forest degradation	0	0	**0**
Peat extraction	0	0	**0**
Drainage organic soil	0	0	**0**
Rewetting organic soil	0	0	**0**
Fire organic soil	0	0	**0**
Coastal wetlands	0	0	**0**
Inputs & Investments	111,907	57,797	**-54,110**
Fishery & Aquaculture	0	0	**0**
Total	-328,537	-2,775,080	**-2,446,543**

The project does account for four main sub-components which widely dominate the impact of the project in terms of carbon balance and Climate mitigation. The GHG mitigation impact of the project estimated at 163,103 tCO2e per year is shared between these components as follows.

Figure 19: GHG appraisal by sub-components

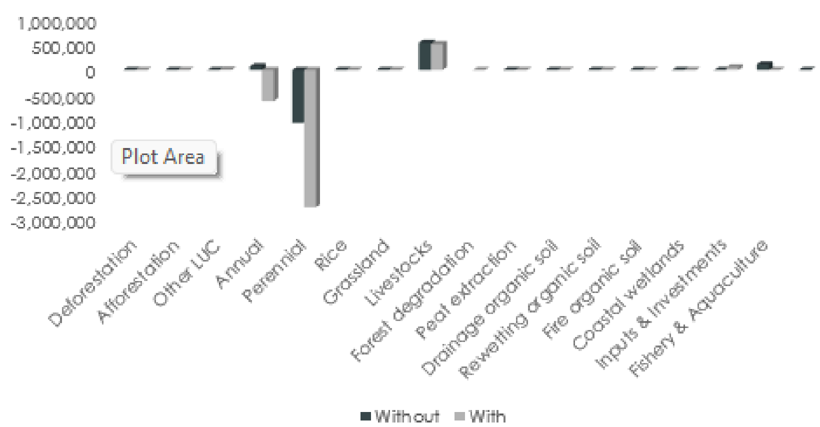
	per year		on 15 years	
Total GHG carbon balance ofGCF Save the Children Project	-163,103	TCO2e per year	-2,446,543	TCO2e
GHG impact of Agroforestry component (shea, gum)	-111,244	TCO2e per year	-1,668,656	TCO2e
GHG impact of solar energy pumps and irrigated crops	-3,634	TCO2e per year	-54,512	TCO2e
GHG impact of biogas units and reduced wood consumption	-5,137	TCO2e per year	-77,054	TCO2e
GHG impact of CSA cereals	-43,088	TCO2e per year	-646,320	TCO2e

ANNEX 1: COMPLETE MATRIX OF RESULTS PER COMPONENT EX-ACT

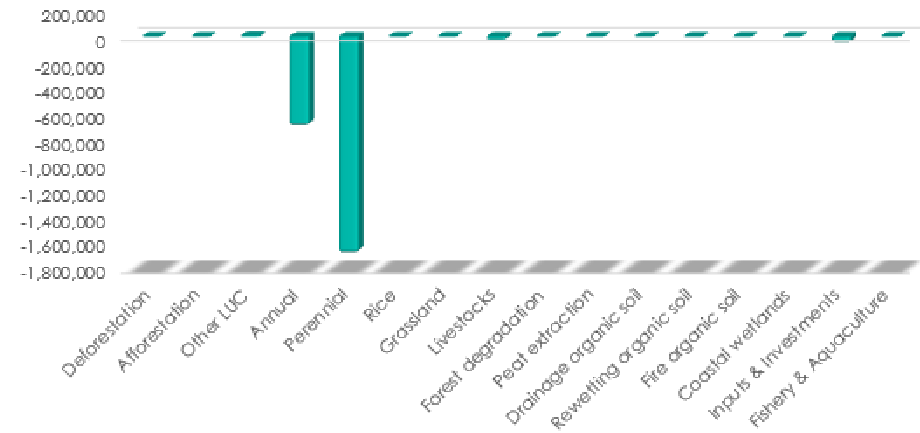
Project Name	*GCF Save the Children MALI*	**Climate**	*Tropical (Dry)*	**Duration of the Project (Years)**	*15*
Continent	*Africa*	**Dominant Regional Soil Type**	*Sandy Soils*	**Total area (ha)**	*57682.5*

Components of the project	Gross fluxes			Share per GHG of the Balance					Result per year		
	Without	With	Balance	All GHG in tCO2eq					Without	With	Balance
	All GHG in tCO2eq			CO_2			N_2O	CH_4			
	Positive = source / negative = sink			Biomass	Soil	Other					
Land use changes											
Deforestation	0	0	0	0	0		0	0	0	0	0
Afforestation	0	0	0	0	0		0	0	0	0	0
Other LUC	0	7,577	7,577	25,479	-17,903		0	0	0	505	505
Agriculture											
Annual	71,917	-622,253	-694,170	0	-634,239		-11,097	-48,834	4,794	-41,484	-46,278
Perennial	-1,056,586	-2,733,041	-1,676,455	-1,663,462	-12,994		0	0	-70,439	-182,203	-111,764
Rice	0	0	0	0	0		0	0	0	0	0
Grassland & Livestocks											
Grassland	0	0	0	0	0		0	0	0	0	0
Livestocks	544,225	514,840	-29,385				-26,197	-3,188	36,282	34,323	-1,959
Degradation & Management											
Forest degradation	0	0	0	0	0		0	0	0	0	0
Peat extraction	0	0	0		0		0	0	0	0	0
Drainage organic soil	0	0	0		0		0	0	0	0	0
Rewetting organic soil	0	0	0		0		0	0	0	0	0
Fire organic soil	0	0	0	0				0	0	0	0
Coastal wetlands	0	0	0	0	0		0	0	0	0	0
Inputs & Investments	111,907	57,797	-54,110			-90,987	36,878	0	7,460	3,853	-3,607
Fishery & Aquaculture	0	0	0			0	0	0	0	0	0
Total	-328,537	-2,775,080	-2,446,543	-1,637,982	-665,136	-90,987	-416	-52,022	-21,902	-185,005	-163,103
Per hectare	-5.7	-48.1	-42.4	-30.0	-11.5	-1.6	0.0	-0.9			
Per hectare per year	-0.4	-3.2	-2.8	-2.0	-0.8	-0.1	0.0	-0.1	-0.4	-3.2	-2.8

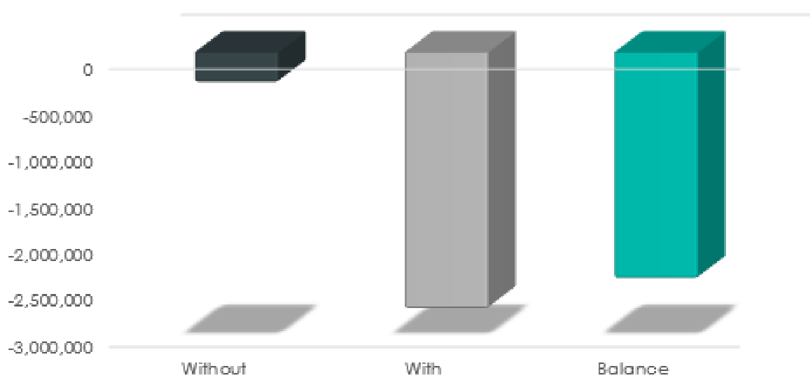
Fluxes per component



Balance per component



Total without and with project and balance



Share of the balance per GHG (plus origin for CO2)