## Ex-Act Methodology for GCF Inclusive Green Finance Programme Phase 1 (Burkina Faso, Mali, Senegal, Côte d’Ivoire, Ghana)

## Introduction

The Ex-Ante Carbon-balance Tool (EX-ACT) is an appraisal system developed by FAO providing 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 greenhouse gases (GHGs) expressed in CO2 equivalent 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 analyses as well as for the application for additional project funds.

EX-ACT can be applied on a wide range of development projects from all AFOLU sub-sectors, including besides others projects on climate change mitigation, sustainable land management, 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) which can help finding the required information. While EX-ACT is mostly used at project level it may easily be up-scaled to the programme/sector level and can also be used for policy analysis.

With the above capabilities, the EX-ACT tool was selected for calculation of estimated carbon mitigation in the associated GCF Funding Proposal for Mali, Côte d’Ivoire, Burkina Faso, Ghana and Senegal. Here, it is important to note that at the Tier 1 level data used by the EX-ACT tool is based on estimates averaged for West Africa and the Sahel and are therefore not context specific. **Consequently, data included in this analysis has been adjusted to the Tier 2 level to be specific to climate resilient agricultural practices in the selected countries.** Data adjustments to the regional level have been made through expert consultation and literature review.

## Methodology

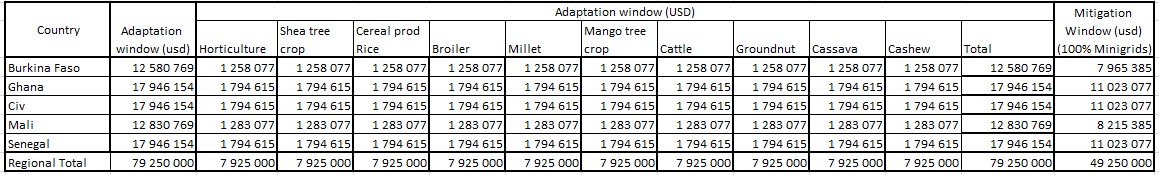
*Timeframe:* **The implementation phase of the program will be six years, whilst the capitalisation phase of the program is estimated at a further 19 years.** This is the estimated time that the program’s activities will need to achieve maturity and their full carbon sequestering capacity. This accounts for both climate resilient agricultural practices (such as maturity of orchards) and the average life cycle of Photovoltaic solar panels.

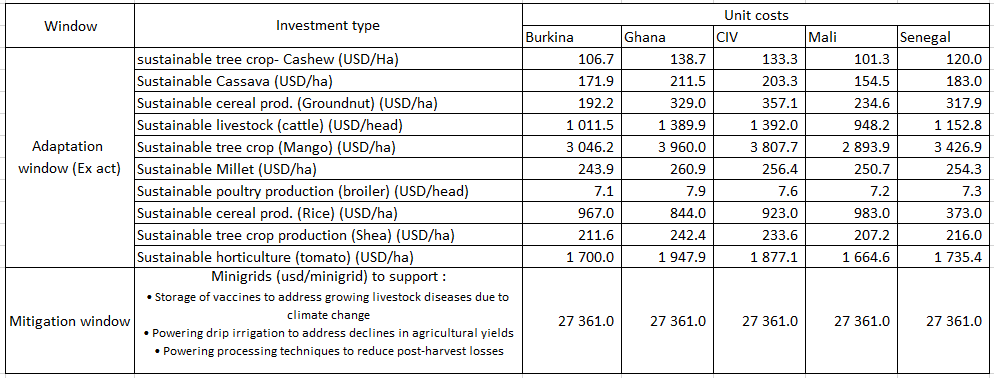
*Categorization:*

The credit lines for adaptation and cross cutting activities are created With combined co-financing of (GCF 60 000 000 USD, IFAD 7 000 000 USD, National Agricultural Banks 5 000 000 USD and IsDB 7 250 000 USD). This amount is shared among Senegal, Mali, Burkina Faso, Ghana and Cote d’ Ivoire in sustainable practices throughout the following value chains:

|  |  |  |  |
| --- | --- | --- | --- |
| **Sector** | | **Climate risks** | **Evidence of impacts** |
| **Sustainable livestock production** | Cattle  10% | Projected increases in temperatures, rainfall variability and frequency and length of droughts across the Sahel expected to reduce food and water availability for cattle, contribute to disease/pest outbreaks, affect reproductive cycle (reduce calving rates from 60-70% to 25-30%) and growth, and degrade pastureland further. | Livestock disease kills 20% of ruminants in developing countries. Desertification and land degradation have resulted in loss of pastureland. Higher temperatures found to reduce feed intake, milk production, fertility and lead to energy deficits. During major droughts in the past, farmers reported losing entire herds. |
| Poultry  10% | Projected increases in temperatures, high humidity, sunshine intensity has a negative effects on poultry production, contribute to disease/pest outbreaks , affect cost of production and number of birds to raise for egg and meat production in the farm, feed grain availability, this implies that high temperature and low rainfall are climatic factors that affect general grain harvest, their supply to the market and ultimately cost of poultry production | Livestock disease kills 20% of ruminants in developing countries. Desertification and land degradation have resulted in loss of pastureland. Higher temperatures found to reduce feed intake egg production, lead to feed grain availability The increase in temperature ultimately increased the mortality rate of meat type chickens by 8.4%, layer birds by 0.84%, and indigenous chickens by 0.32%. |
| **Sustainable Horticulture and vegetable production** | Horticulture (tomato)  10% | High temperatures, excess water or drought reduce productivity levels. Heat also impacts farmers’ ability to market and conserve tomatoes, which are highly perishable. Climate variability increases incidence of disease. | Studies show significant declines in yields due to heat and water stress. High temperatures affect plant growth and reproduction, with increased incidence of abortion of fruit. Lack of water results in formation of fewer flowers and affects pollen. Farmers reported poor yields due to climate change. |
| **Restoring degraded land and agroforestry** | Sustainable Mango with native species (agroforestry- alley cropping)  10% | Negative impacts of water stress and extreme temperatures on flower induction, fruit set and pollen survival. CC scenarios predict a rapid decline in the number of induction days by end of century. Shorter flowering periods reduce productivity. Rainfall variability – especially if there is rain during flowering period – may also reduce yields. | Influence of climate change on yield, time of maturation and quality |
| Cashew production with native species (parklands)  10% | Increased temperature, rainfall and humidity can lead to higher incidence of pests and disease, two major constraints to cashew production. Irregular rainfall, violent winds and prolonged drought can impact yields and quality. Though highly tolerant to drought, low rainfall during vegetative stage can prevent trees from obtaining enough water to sustain flowering. | Higher temperatures, erratic rainfall and increases in humidity increase the incidence of pests and disease. Irregular rainfall and temperature changes have been found to affect production. |
| Sustainable Shea Production  (parklands)  10% | Favourable habitats of shea trees will decline by 13% (RCP8.5) by 2070 due to climate change. Higher risk of losing flowers and fruit due to heavy rainfall and winds; drought, flooding and wildfires increasing tree mortality and inhibit harvesting; decrease in water supply affecting growth and limiting processing; more frequent and prolonged droughts leading to the abortion of fruit. Deforestation biggest threat. | Higher temperatures and changes in rainfall patterns are already causing the trees to shift southward, with impacts on the trees’ growth, regeneration and production levels. |
| **Sustainable cereals-staple crops production** | Sustainable Rice production  10% | Increasing climate variability (rainfall) and high temperatures disrupt growing seasons. Greater risk of prolonged drought, heat waves, floods, water shortages, strong winds and storms, pests and diseases, causing substantial yield reductions or crop failure, which are higher for rainfed production. SLR increases risk of floods and salinization | Estimated reductions in rice yield range from 5-25% and up to 80%, in irrigated rice systems in the hot-dry season and around 40% in rainy season. |
| Sustainable Cassava production  10% | Though resilient to climate change stressors, cassava production will be vulnerable to pests and diseases. | Over a third of attainable cassava yield is lost every year to pests and disease, which could be exacerbated by higher temperatures (e.g. whitefly). |
| Sustainable Groundnut production  10% | Though moderately drought resistant, excessive heat and prolonged drought limit yields. Rainfall variability is in important risk as germination is poor in drier soils, whereas excessive moisture increases plant mortality and incidence of disease. Average production expected to decrease 11% over next 20 years. | Temperatures above 33˚C found to decrease growth by up to 84%. Higher temperatures will have most dramatic impact on yields, which are traditionally low due to unreliable rain, poor soils, pests and disease. |
| Sustainable Millet Production  (parklands)  10% | Though well-adapted to hot areas, temperature increases higher than 2°C are projected to decrease millet yields by 10% over next 20 years and 15-25% by 2080. Rain variability contributes to lower yields, primarily excess rain during flowering, which can cause crop failure. | Production predicted to decrease on average by 10% over next 20 years. |

Thus each value chain is allocated 10% of the adaptation window (See table below)



*Unit calculations to run EX ACT:* The proposed program is focused on providing credit lines at 0 % interest rates to smallholder farmers to invest in mitigation and adaptation measures and climate resilient practices. The exact number of units of land that will be under implementation and head of small livestock is based on the following table of units ( mini-grids are modular and the cost indicated is per 8kW system) 

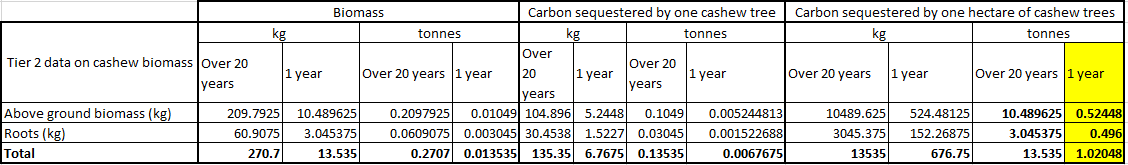
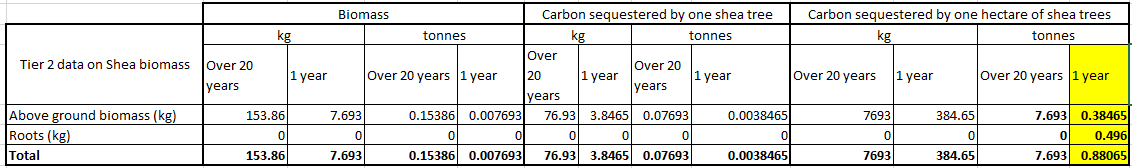
The unit costs were then applied to each individual category as follows:

**Agroforestry (planting of parklands and alley cropping):**

*Number of Hectares =10% of country envelope for adaptation window / Cost per Hectare*

Climate resilient agricultural practices/ activities are well documented by development agencies in the region. We consider that sustainable agroforestry practices will take place through the mango tree alley cropping , shea trees and cashew parklands. Most of these activities will be carried out on already existing plantations, we assume that only 5% of the investment on each of these value chains will finance new plantations which will be calculated under the “other LUC”activities of the EX-ACT Tool. Furthermore we used tier 2 data for carbon sequestration based on the biomass of one mango tree, one cashew tree and one shea tree and the rule of 50% of carbon in biomass to run the perennial cropland module in EX ACT (See table below).



References:

* Mango trees biomass : <https://www.researchgate.net/publication/305394050_Biomass_Distribution_and_Development_of_Allometric_Equations_for_Non-Destructive_Estimation_of_Carbon_Sequestration_in_Grafted_Mango_Trees>
* Cashew tree biomass: <https://pdfs.semanticscholar.org/a087/19f4837cb01ddeb9e76b785cd22280409f2d.pdf>
* Shea tree biomass:

<https://www.researchgate.net/publication/323264723_Aboveground_biomass_allometric_equations_and_carbon_content_of_the_shea_butter_tree_Vitellaria_paradoxa_CF_Gaertn_Sapotaceae_components_in_Sudanian_savannas_West_Africa>

Average cost of sustainable tree crop production through agroforestry:

Shea: USAID (2016) Ghana Agriculture and Natural Resource Management Project: Natural Resource Product Sector Analysis – Shea Roadmap. Agreement Number: AID-641-A-16-00010

Mango: <https://www.researchgate.net/publication/326059441_Cost-benefit_analysis_and_water_productivity_of_MIS_for_a_crop_production_in_Kodinar_region_of_Gujarat>

Cashew: <https://unctad.org/system/files/official-document/ditccom2020d1_en.pdf>

**Agriculture under sustainable practices :**

We conducted a literature research to extract the average unit costs for each value chain activity per country.

Thus the formula we used to extract the number of hectares is the following:

*Number of hectares= 10% of country envelope for adaptation window per value chain/ unit cost of production for 1 ha of land*

References:

Cost of sustainable practices for horticulture: <https://www.ceew.in/sites/default/files/Agrawal-Jain-2018-Sustainable-solar-irrigation.pdf>

Cost of SRI: <https://www.adaptation-fund.org/wp-content/uploads/2021/05/OSS_RIE-Regional_Full_Proposal-RICOWAS_Project-Benin-al-26April2021.pdf>

Cost of sustainable agricultural practices for millet vc: <https://www.sei.org/publications/evolution-of-agricultural-water-management-in-rainfed-crop-livestock-systems-of-the-volta-basin/>

Cost of sustainable agricultural practives for groundnut vc: https://documents1.worldbank.org/curated/en/523961498623774515/pdf/Final-report.pdf

Cost of sustainable agricultural practives for cassava vc: <https://www.researchgate.net/publication/286319562_Comparison_of_carbon_sequestration_between_multiple-crop_single-crop_and_monoculture_agroforestry_systems_of_Melaleuca_in_Java_Indonesia>

**Livestock:**

The purchase of livestock is inputted in the Ex-act and counts as a small amount of carbon emissions produced by the project (one goat or sheep emits 5 kilos of methane per year). The average costs for poultry and cattle are also extracted from research on literature and articles.

*Number of poultry/cattle= 10% of country envelope from adaptation window for each livestock type/ average unit cost of production for one chicken/cattle*

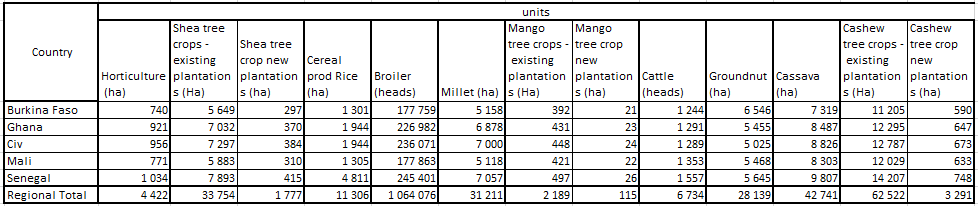
References:

Cost of poultry (example of Senegal but each country of the Sahel has the same kind of livestock markets information system): <https://www.poultryworld.net/Home/General/2020/1/Case-study-Chicken-remains-a-luxury-in-Senegal-521334E/>

Cost of cattle: <https://www.frontiersin.org/articles/10.3389/fvets.2021.616865/full>

**Application of methodology to each country envelope:**

These figures were then applied to the individual country envelopes to extract the amount of units dedicated to each category to be inputted into EX-ACT, please see tables below.



**List of measures introduced by the project and mitigation impacts:**

EX ACT estimates the sequestration of carbon through a range of activities related to new plantations of perennial trees for agroforestry practices, the deployment of solar mini grids for agriculture and agriculture under sustainable practices (as described in FP).

The main source of emission/reduction identified in the EX ACT analysis per country are through the following activities:

**Agroforestry through parklands and alley cropping:**

Establishing agroforestry on land that currently has low tree cover has been identified as one of the most promising strategies to raise carbon stocks on currently productive land without compromising food and fiber production (Albrecht and Kandji 2003; Kuersten and Burschel 1993; Montagnini and Nair 2004). Agroforestry is the deliberate integration of trees or other woody perennials into field crop or livestock systems, in order to exploit synergies and complementarities between different structural elements of the system. Agroforestry has been shown in many instances to lead to more diverse, more productive and more sustainable agricultural production than less integrated approaches (e.g. Cannell et al. 1996; Nair 2007; Sinclair 1999; Van Noordwijk and Lusiana 1998). Carbon stock increases resulting from conversion of treeless land to agroforestry have been estimated at 3 Mg C ha−1 a−1 in tropical regions (IPCC 2000). Conversion of agricultural land to agroforestry has also been reported to entail substantial co-benefits for farmers, such as enhanced soil fertility, resilience to weather extremes and additional sources of farm income (Ajayi et al. 2007; Garrity 2004; Sanchez 1995). Tree-based agricultural systems in many parts of the world have been shown to have higher carbon stocks than treeless farming systems (Luedeling et al. 2011; Nair et al. 2009a, b) and to provide more environmental services (Jose 2009; Paustian et al. 1998).

Parklands are generally understood as landscapes in which mature trees occur scattered in cultivated or recently fallowed fields (Pullan, 1974; Sautter, 1968, cited in Raison, 1988). In the ICRAF Agroforestry Systems Inventory, agroforestry parklands are included in the very general category of ‘multipurpose trees on farmlands’ (Nair, 1985). Livestock production may be a significant or secondary component in these systems. Because of the variety of field realities encompassed, the notion of parklands has been interpreted widely and its terminology is still very much under discussion. [[1]](#footnote-1)Where parkland areas can be expanded, these may help farmers adapt to the impacts of climate change. Unlike rainfed annual crops, trees can draw water from deeper soil layers and are thus able to produce food, fodder and fiber, even when annual crops fail. Fertilizer trees can provide much-needed resources that allow raising yield levels. Finally, trees on farms can help diversify incomes and thus buffer farmers against the economic shocks that may occur during years of unfavorable weather.

Among AF practices, alley cropping refers to the growing of arable or herbaceous crops in wide alleys defined by rows of trees and possibly shrubs. Alley cropping has been shown to increase the overall productivity and resilience of agricultural systems and is a promising new land-use type in for CC mitigation (e.g., carbon storage)[[2]](#footnote-2).

The key drivers of CC adaptation in alley cropping include:

* Improved organic matter content, soil structure and stability, water infiltration and field capacity, reduced erosion;[[3]](#footnote-3)
* Increased available nitrogen and improvement of nitrogen cycling, and thus reduced risk of nitrogen deficiency and leaching[[4]](#footnote-4);
* Increases in the overall light use efficiency[[5]](#footnote-5)
* Alleviation of temperature and water stresses on crops due to mitigation of the crop microclimate (reduced radiation, reduced air and soil temperature, increased air humidity, reduced wind velocity)[[6]](#footnote-6);
* Slowdown in the crop phenology that may allow to capture more light and nitrogen by lengthening the growing season[[7]](#footnote-7)

**Sustainable agriculture through use of manure, improved agronomic practices, tillage systems and improved water management:**

* Improved agronomic practices such as Crop rotations and intercropping are designed to ensure differential nutrient uptake and use (e.g. between crops, such as millet and cassava and Nitrogen-fixing crops, such as groundnuts, beans and cowpeas), will enhance soil fertility, reduce reliance on chemical fertilizers, and enrich nutrient supply to subsequent crops (Conant 2010), leading to increased crop yields (Woodfine 2009).
* Tillage systems (which adopt no-tillage, minimum tillage and crop residue management) provide opportunities for increasing soil water retention. Therefore crop yields are often higher than under conventional tillage (Derpsch & Friedrich 2009), especially in semi-arid and dry sub-humid agro-ecosystems. For example, substantial increases in rain use efficiency with implementation of conservation tillage practices in Sub-Saharan Africa are reported by Rockstrom et al. (2009).
* The use of organic fertilizer, as an alternative environment-friendly approach with multi-advantages over chemicals, is key under a Sahelian climate. The maintenance of organic matter enhances the organic carbon level, biotic activity and nutrients availability of the soil, which ultimately assures its physical, chemical and biological fertility. It also improves soil structure and its water holding capacity with minimum leaching.[[8]](#footnote-8) Maintaining regular incorporation and recycling of organic wastes to the soil is necessary to attain optimum levels of organic matter and various essential nutrients under the current situations.
* Improved water management through System of Rice intensification: The System of Rice Intensification (SRI) is a farming methodology aimed at increasing the yield of [rice](https://en.wikipedia.org/wiki/Rice) produced in [farming](https://en.wikipedia.org/wiki/Farming). It is a low-water, labor-intensive method that uses younger seedlings singly spaced and typically hand weeded with special tools. It was developed in 1983 by the [French](https://en.wikipedia.org/wiki/France) [Jesuit](https://en.wikipedia.org/wiki/Jesuit) [Father](https://en.wikipedia.org/wiki/Priest) [Henri de Laulanié](https://en.wikipedia.org/wiki/Henri_de_Laulanie) in [Madagascar](https://en.wikipedia.org/wiki/Madagascar).[[9]](#footnote-9)

**Solar mini grids for agriculture :** IGREENFIN will provide concessional finance to small farmer cooperatives and private sector for owning mini-grids which will provide clean energy to support agricultural value chains. Energy demands for agricultural processing and transformation within IGREENFIN scope of work have been estimated at 20736 MWh annually within the 5 countries. These demands are to support the following activities:

* Storage of vaccines to address growing livestock diseases due to climate change
* Powering drip irrigation to address declines in agricultural yields
* Powering processing techniques to reduce post-harvest losses

The energy demands will be fully covered by mini-grids systems consisting of solar + storage solutions. In the absence of the GCF proceeds these energy demands would be covered by farmers using diesel generators which would lead to an estimated 22,579 tCO2 eq emissions annually across the 5 countries of the programme. Annex 23 Energy emissions provide the detailed calculation of GHG reduction which will be achieved through the deployment of these mini-grids. The approach is the CDM methodology on renewable energy electricity generation for captive use and mini-grid [[10]](#footnote-10)

With overall technical losses of the solar systems estimated at 20% and an Emission factor of 1.4 tCOeq/MWh overall emissions have have been estimated at 638,669 tCO2eq over the 25 years lifetime of mini-grid systems as demonstrated in the following table :

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Year** | **Estimation of baseline emissions** | **Estimation of  project activity  emissions** | **Estimation of leakage** | **Estimation of  overall emission  reductions by solar systems** |
| **(tCO2e)** | **(tCO2e)** | **(tCO2e)** | **(tCO2e)** |
| **Year 1** | 29,030 | 0 | 0 | 29,030 |
| **Year 2** | 28,740 | 0 | 0 | 28,740 |
| **Year 3** | 28,450 | 0 | 0 | 28,450 |
| **Year 4** | 28,159 | 0 | 0 | 28,159 |
| **Year 5** | 27,869 | 0 | 0 | 27,869 |
| **Year 6** | 27,579 | 0 | 0 | 27,579 |
| **Year 7** | 27,289 | 0 | 0 | 27,289 |
| **Year 8** | 26,998 | 0 | 0 | 26,998 |
| **Year 9** | 26,708 | 0 | 0 | 26,708 |
| **Year 10** | 26,418 | 0 | 0 | 26,418 |
| **Year 11** | 26,127 | 0 | 0 | 26,127 |
| **Year 12** | 25,837 | 0 | 0 | 25,837 |
| **Year 13** | 25,547 | 0 | 0 | 25,547 |
| **Year 14** | 25,256 | 0 | 0 | 25,256 |
| **Year 15** | 24,966 | 0 | 0 | 24,966 |
| **Year 16** | 24,676 | 0 | 0 | 24,676 |
| **Year 17** | 24,386 | 0 | 0 | 24,386 |
| **Year 18** | 24,095 | 0 | 0 | 24,095 |
| **Year 19** | 23,805 | 0 | 0 | 23,805 |
| **Year 20** | 23,515 | 0 | 0 | 23,515 |
| **Year 21** | 23,224 | 0 | 0 | 23,224 |
| **Year 22** | 22,934 | 0 | 0 | 22,934 |
| **Year 23** | 22,644 | 0 | 0 | 22,644 |
| **Year 24** | 22,353 | 0 | 0 | 22,353 |
| **Year 25** | 22,063 | 0 | 0 | 22,063 |
| **Total** (tCO2e) | 638,669 | 0 | 0 | 638,669 |

**GWP:**

The GWP used for each country is aligned to each individual national reports and BURs to the UNFCCC. Thus for Mali, Burkina Faso, Côte d’Ivoire and Senegal the Second Assessment Report figures were applied while for Ghana we used the GWP from AR4.

**Baseline for the EX ACT analysis:**

Our assumption is that the hectares of degraded land will remain degraded land without the project. The situation without project for agroforestry practices is neutral, the levels of degradation are the same in the long term. The reason is the very high level of degradation. On degraded land in Sahel countries the level of biomass is around zero on crusted soils. The reasons of this situation are:

* Lack of knowledge on the relevant practices, due to the absence of extension services in remote areas
* Lack of income to implement the practices: more than 50% of the farmers of these zones are poor, with less than 5 ha and are suffering from food insecurity during a few months in the year.
* Low organization at the community level
* Policies and NDCs aiming at promoting these practices at scale only if additional external funding is available

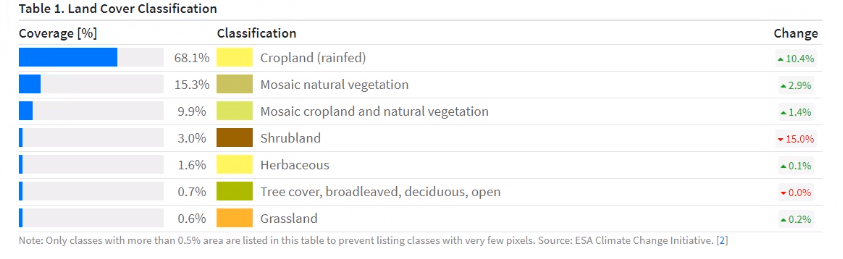
Land degradation trends are often negative in the Sahel. Below is a sample of regions of the Sahel and the Coastal countries showing neutral or negative trends in terms of land degradation monitored through land cover changes between 1995 and 2015 (average areas of 5000 km2, data generated from [www.geofolio.org](http://www.geofolio.org)). These examples have been taken in zones where farmers clear the bush to set up new plots. It is expected that the project activities will refrain these trends, through the generation of sustainable incomes on a fixed area of land.

Senegal: Kaffrine Area (Neutral trend)

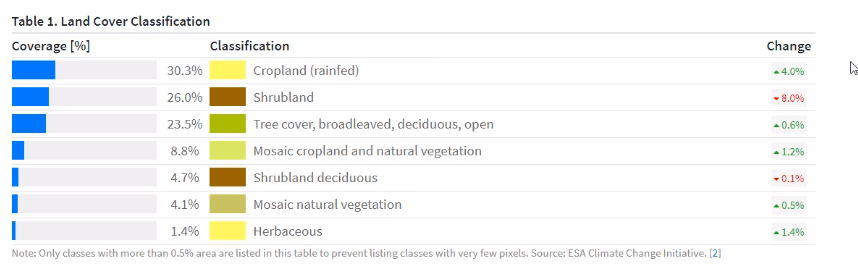
Mali: Region of Kita: loss of grassland and expansion of cropland on low fertile land



Burkina Faso: area of Houndé (Sahel region): expansion of cropland against savannah shrubland



Ghana: Tamale region: expansion of cropland on savannah shrubland



Côte d’Ivoire: Korhogo region: expansion of cropland on savannah shrubland

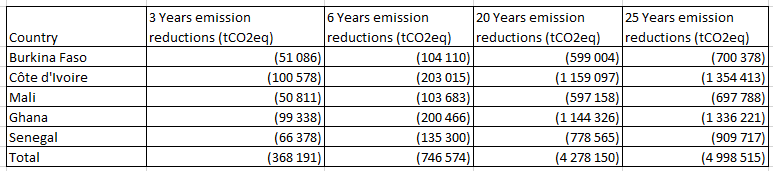


**Leakage issues:**

This project will not lead to leakage issues because additional income will be produced by restored or improved land (fruit, vegetables, cereals). It is very unlikely than the beneficiaries cut or degrade neighbouring forests. The additional income expected is a good incentive to avoid leakages and improves their livelihoods. Further, there will be no use of biomass for the renewable energy systems.

**Timeline of carbon sequestration:**

The results are currently provided over 25 years with the possibility to estimate amounts for mid-term and project completion. We do not think that it is realistic to provide a table by year regarding carbon sequestration linked to land use. The reason is that the trends cannot be anticipated accurately and will not be linear. Implementation of the activities will depend on the time needed for social studies and dialogues with community members. Clarity on land tenure, collective management of restored land and rules to be applied takes time and depends on the local context. Providing expected figures at mid-term and completion seems more realistic.

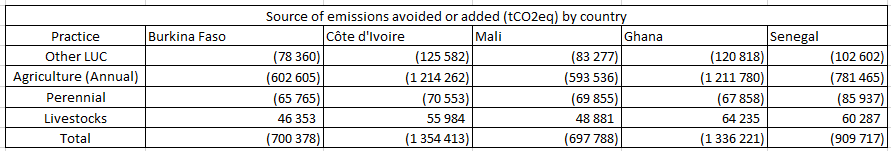


## Results

Utilising the above inputs the EX-ACT tool estimates that through the funding of the previously mentioned climate resilient agricultural techniques the program is estimated to have a mitigation co-benefit of -5 637 184 tCO2eq over the program’s capitalisation timeframe. For more details please refer to the individual country EX-ACT Calculations and Annex on renewable energy calculation.

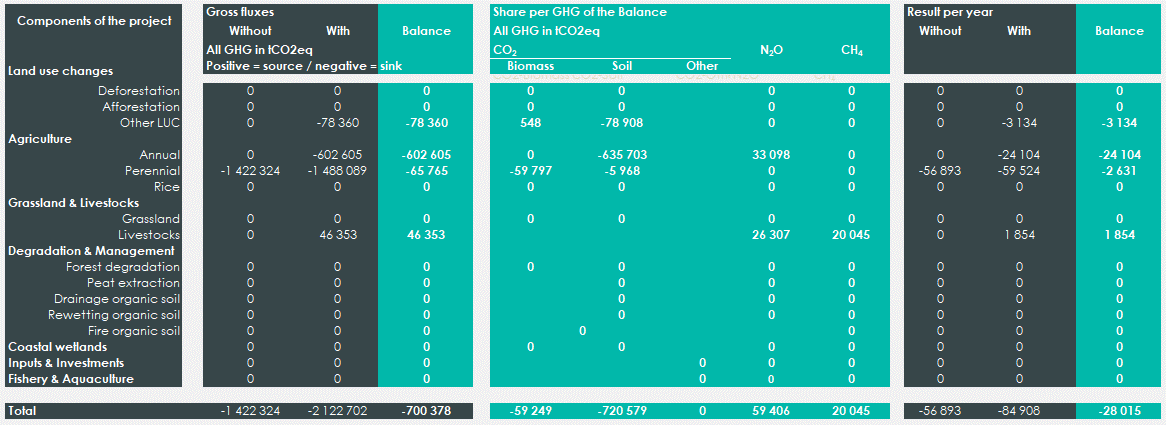
A breakdown of the tCO2eq by individual activity is presented below in table 3.

Table 3: Breakdown of estimated mitigation of tCO2eq by individual activity (adaptation window)

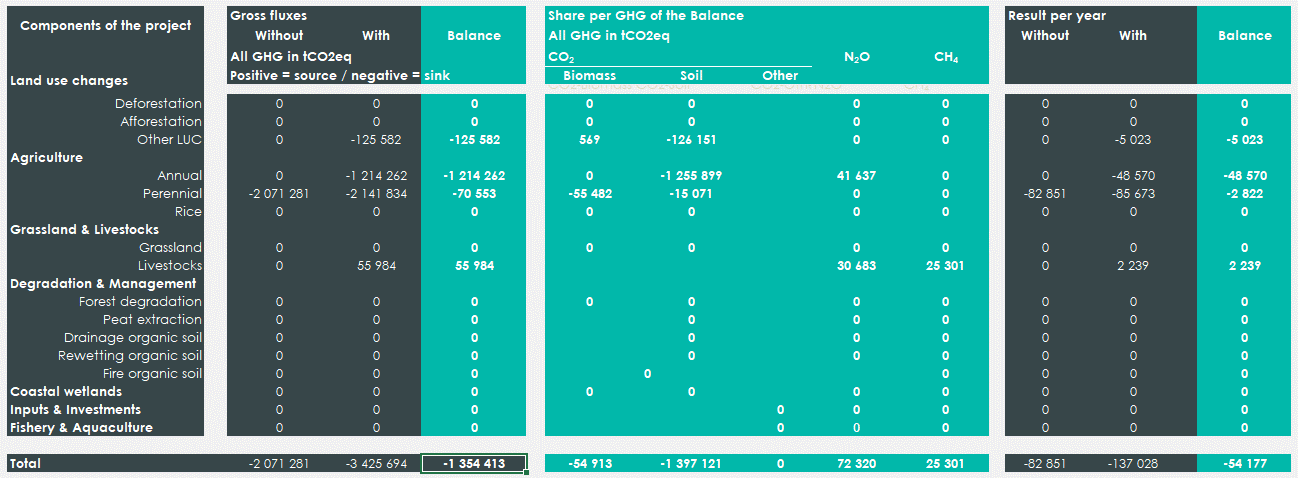


**Annex 1**

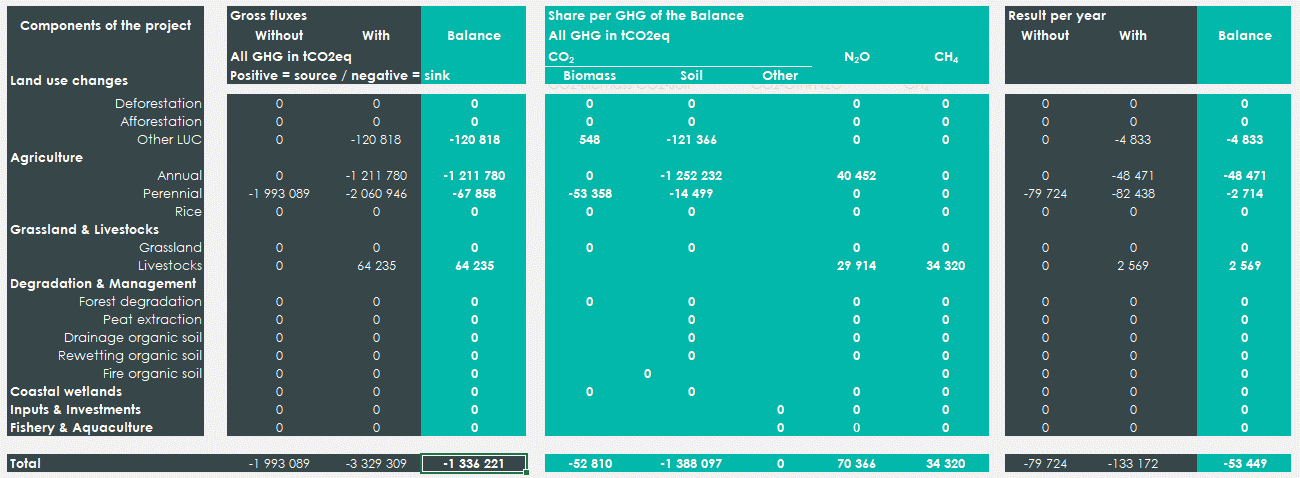
Burkina Faso



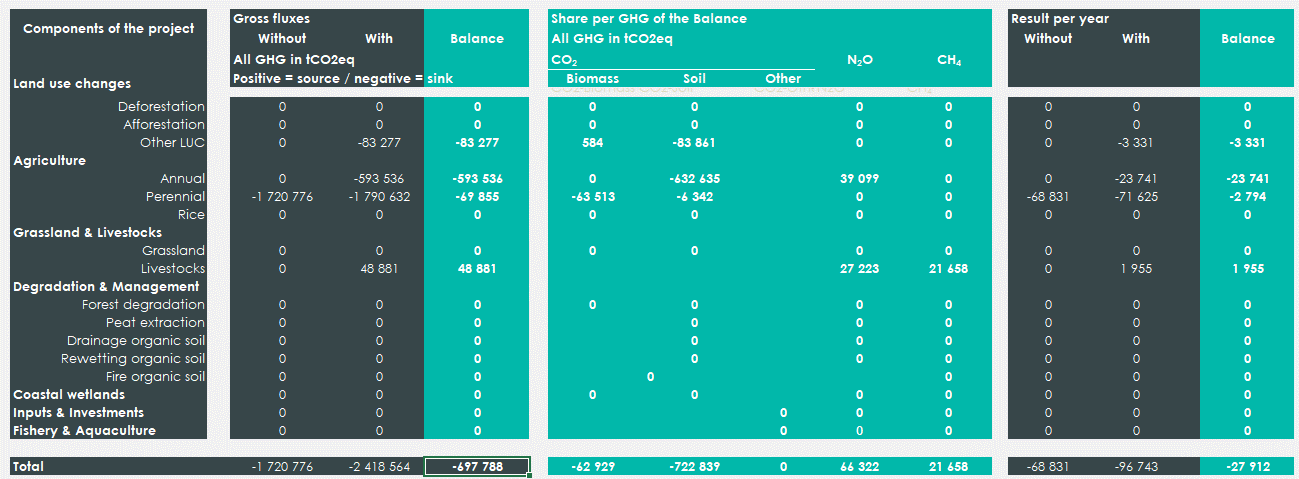
Côte d’Ivoire



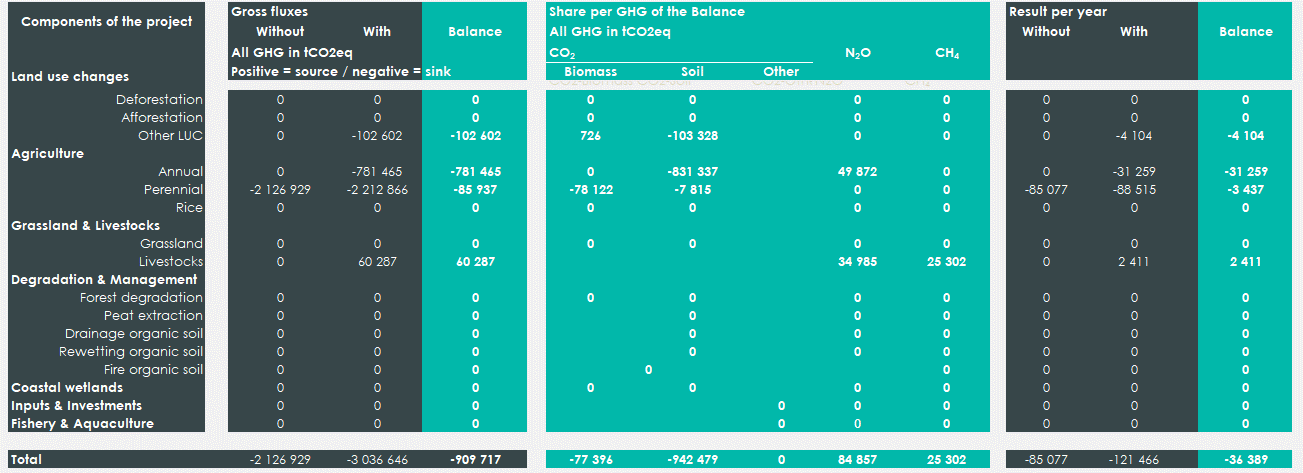
Ghana



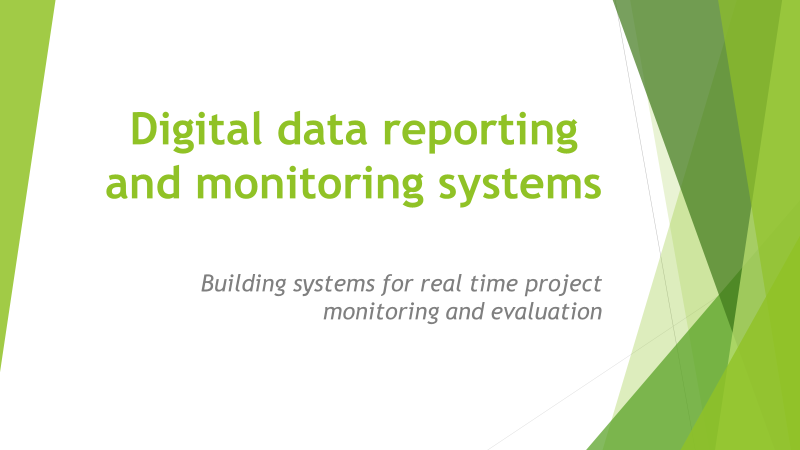
Mali



Senegal



**Annex on digital data reporting and monitoring systems for the GCF Inclusive Green Financing Initiative (IGREENFIN): Greening Agricultural Banks & Financial Sector to Foster Climate Resilient, Low Emission Smallholder Agriculture in the Green Great Wall (GGW) countries**

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# Introduction and context

For many development organizations, front and back office project integration systems will prove to be a dominant strategic issue for many years to come. Some institutions are already feeling the pressure to improve the monitoring and evaluation processes as well as the reporting systems of their projects. Integrating projects means that organizations need to take a portfolio approach to management of projects and that means consolidating performance reporting, to streamline the process and minimize the time commitment for management oversight. Two significant components of project integration lie in the areas of project management collaboration and project management metrics and reporting, both across projects and upward/downward from project managers to implementing partners. It seems to many organizations that all that is preventing the next sea change in project performance, is simply a concise and timely method for monitoring project progress and sharing project and portfolio metrics, without the need to congregate project teams in the same room, or to schedule executives and project managers to meet, either around a video conference or the same conference table.

Project partners are becoming more inquisitive about the way data are been collected and reported, and there is a need to modernize the way project information is collected, organized, disseminated and used in day-to-day project management. There are more and more largescale and multiparters projects that are facing the challenging of real time reporting. The managers of such projects will like to be able to have systematic oversight of the project implementation and measure progress toward meeting the targeted objectives. The concept of utilizing “digital data reporting and monitoring systems” as a tool for reporting performance metrics and collaborating on project decision making, has begun to attract more attention nowadays. Additionally, project planning and management, which includes comprehensive planning and control for all of project phases, could be assisted with the use of Digital data reporting and monitoring systems (DRMS) that combine digital dashboards and geoportals.

Digital data reporting and monitoring systems are based on the metaphor of an automobile instrument panel and are a new project management tool that can be used to get a bird's eye view of a projects health and performance. They are simple and powerful data-driven software solutions that are used to visually ascertain the status and key performance indicators of a project, or a portfolio of projects. DRMS provide digital at-a-glance displays of critical data pulled from different databases to provide warnings, action notices, and summaries of project conditions.

DRMS can be set up to track the information flows inherent in projects that they monitor. Graphically, users can monitor high level processes and if necessary, drill down into low level data. The success of DRMS depends mostly on the proper selection of project metrics (key performance indicators) to monitor. In the past, this information was typically unavailable to senior managers, outside of attending a slide presentation, thumbing through massive activity and financial reports, or scrolling endlessly through screen-formatted reports. The benefits of DRMS are numerous for project teams and partners at various level. The key is to have all activities contributing to the overall project success be connected so that all project functions can be monitored, and management is able to access the progress of each activity et will. This is a type of executive information system that allows managers to gauge how well the project is performing. It allows the organization to capture and report specific data points from each activity within the project so as to provide a “snapshot “of performance. Managers can see key changes in their operations almost immediately and can take quick corrective action.

# Digital data reporting and monitoring systems in the context of the IGREENFIN GGW UP.

Digital data reporting and monitoring systems (DRMS) will be repositories designed and developed to collect, consolidate treat, analyze and visualize data collected within the frame of project implementation. Depending on project objectives and specificities, DRMS will have the potential to 1) enable data entry for regulated entities/projects/institutions, 2) review data, consolidate and analyze for categories of stakeholders based on interests, 3) increase data accuracy, completeness, and consistency, 4) centralize data collection, facilitate interaction between partners, regulate entities and verifiers, as well as efficient communication with key stakeholders, 5) track time series of project milestones and measure progress against targets and strategies, 6) visualize and share spatial outputs at various levels through dashboards and geoportals

The system will help project and partners demonstrate achievements, compliance, leadership, and transparency to shareholders and the public, as well as publicly track information such as emission reductions and carbon stocks. The systems will also be effective for government to advance to a paperless form of collecting emissions information, and secures more accurate, consistent data in a centralized repository. Project stakeholders will have access to data more easily so they can make informed decisions about the projects and implementation partners. By disseminating information that is easily understood, these systems will contribute to empowering project partners and beneficiaries to function as informal evaluators and promote accountability to those being evaluated.

# Key considerations in designing and implementing digital data reporting and monitoring systems

Putting in place a DRMS require the consideration of non-technology-related activities that underpin the development and implementation of an effective DRMS. There will be a need to define the legal and regulatory framework for DRMS and establish the institutional framework for systems to provide proper governance and oversight. This will support effective communication among partners, ensure accountability and support system development, maintenance, and use, and data verification. Ensuring that the roles and responsibilities of each institution are clearly defined is essential in the instance of multiparters project. One other consideration is the stakeholder engagement and consultation. The system put lots of emphasizes on the value of early and continued engagement with stakeholders, particularly reporters in each country. Stakeholder engagements are expected to improve system design and yield multiple benefits, including facilitating the development of a system that addresses national priorities and circumstances; obtaining early buy-in from and engagement with key user groups, such as reporters and verifiers; building capacity and improving preparedness within key user groups, ensuring fewer errors when data is entered into the system; and raising and maintaining public support. Engaging stakeholders is also expected to gauge the system-specific needs and to solicit feedback on system functional components, provide user-specific feedback that can help to refine the system, and build familiarity with the system so that―once the system is operational―users submit higher-quality data. The third consideration is the capacity building at various level to ensure that the system is used effectively and reduces user errors. Providing support to and building the capacity of DRMS users are key to ensuring smooth reporting cycles and accurate data input. Available resources, reporting timeliness, and accuracy requirements are important considerations when determining the appropriate type and level of support and training activities. Options for user support include a help desk, dedicated telephone line or email address, and/or website; training options include user guides, frequently asked questions documents, in-person trainings, and webinars. Verifiers should also be trained in order to increase their understanding of how the system works and support the verification process.

# The legal and regulatory frameworks that determine DRMS

The legal and regulatory frameworks will help frame the design and development of the DRMS.

The primary and enabling legislation, will broadly address overall intent, quality control (QC) and quality assurance (QA) (i.e., internal checks, audit requirements and verification approaches), data use, transparency, and disclosure (i.e., how will the data be used and who will access which information), data sensitivity and confidentiality, and the significance or value of reported data (which will be dependent on the policy objectives of a program). These dictate key program design decisions that need to be considered in data system design. The legal and regulatory frameworks will also address specific roles and responsibilities/authorities of programs and regulations; however, the primary purpose of the regulation is to set standards for how to implement a data reporting program, and outline the specific monitoring, reporting, and verification protocols to be followed.

Since a DRMS is an actualization of the project reporting guidance, establishing clear parameters, indicators, rules/guidelines, and processes that the system will support is an essential first step.

Design elements and decision points include:

* Defining coverage in terms of applicable entities and emissions sources and GHGs (who reports which emissions).
* Providing calculation methodologies for different emissions sources and data monitoring requirements (how to calculate and measure emissions).
* Determining reporting requirements and schedules (what to report and how often).
* Developing reporting platforms and data disclosure rules (where to report and who has access to reported information).
* Deciding on verification procedures for QA and control (who verifies what and how).
* Establishing enforcement rules (what measures to apply in case of noncompliance).
* Determining which, if any, documents and reports are public and if this decision is made by the program or by the reporter.

Solidifying key decisions as part of the legal and regulatory frameworks for the DRMS in advance of developing a data system is critical in terms of efficiency and outcomes. The design of various functional components of the tracking system (e.g., online calculations, QA and QC measures, public reporting) are directly related to the reporting and verification guidance of the program that the system is being designed to support. When developing the regulatory guidance and protocols for the DRMS, the following decision points will shape key inputs into the system design and development process:

* Program coverage and scope: What sectors are covered under the program in each country and are there specified reporting or program inclusion thresholds.
* Level of reporting: Is data reported at the project level or country levels?
* Data types and formats: What types of data are required to be collected? What are the methods and tools for data collection? What units of measure and conversion factors are required?
* Calculation methodologies: What methodologies are required, and which emission factors (e.g., Intergovernmental Panel on Climate Change (IPCC) default emissions factors or country-specific), carbon contents of fuel and raw materials, and global warming potentials (GWPs) are specified?
* Data accuracy: How accurate does the data need to meet the project objective? What verification and QA/QC approaches are required to ensure the level of accuracy?
* Consistency: Are consistent carbon stocks or GHG calculation methodologies required?
* Multiple objectives/adaptability: Do multiple policy objectives need to be met through one program, and are there different data collection requirements to meet these different objectives?
* Frequency: At what frequency does data need to be provided to meet the stated policy objective(s) (e.g., quarterly, annually)?
* Access: Which users may need access to what data?
* Confidentiality: Is there any information being collected that should be kept confidential? What is the level of public access to data being collected?
* Security: how to ensure the security of the data collected?
* Flexibility: Are changes in policies or regulations expected?

# Establishing the Institutional Framework and clearly defined institutional roles and responsibilities

Prior to its implementation, the project will 1) assess the capacity of existing institutions (including related data systems) and the legal framework they support. These institutions could include agencies that are currently collecting information on non-GHG air pollutants, compiling GHG national inventories, or administering existing voluntary GHG reporting programs at the national and subnational levels; 2) evaluate which established legal and institutional frameworks could align and, where possible, seek to leverage technical capacity, expertise, and available resources and 3) establish the roles and responsibilities of all relevant institutions, if shared ownership is possible. Clearly defining the roles and responsibilities of each institution will be critical. Establishing a framework for DRMS governance and oversight will support effective communication, ensure accountability and support system development, maintenance, and use.

# Collaboration with existing data management system

For the IGREENFIN phase 1 programme, the project will explore in each participating country the existing data collection mechanisms in place to support various policies. Some of these systems may have been put in place by the government to have oversight of various environmental problems (e.g. pollution control, energy systems, GHG emission) reporting programs and systems, and therefore could give opportunity for synergies. Collaboration between government ministries, pollution control, energy and climate/carbon departments or agencies will be beneficial for the implementation of the DRMS, given the increasing imperative to collect corporate/facility-level data and the potential opportunity to leverage existing expertise and infrastructure—it is not always necessary to “reinvent the wheel.”

Existing data collection systems and databases within the climate and environment arena in the participating countries may include 1) non-GHG/criteria air pollutant databases collected on non-GHG or criteria air pollutants (such as PM, ground-level ozone, carbon monoxide, sulfur oxides, nitrogen oxides, and lead) because they are regulated under air quality standards; 2) energy databases collected on energy production and consumption data in centralized databases, 3) data management systems and registries related to GHG policies that support a range of GHG policies and actions, such as national GHG inventories under the UNFCCC, the Nationally Appropriate Mitigation Actions (NAMA) Registry operated by the UNFCCC Secretariat for developing countries to register domestic actions to reduce GHG emissions, or carbon asset registries supporting market-based mechanisms. This system will only monitor the emission reduction from biomass and does not include emission reduction from small-scale irrigation or small stock.

# Key steps for the development and implementation of the DRMR

The development and the implementation of the DRMS is made up of key 8 interconnected steps to ensure its proper functionalities and efficiency. The key steps that illustrate the main decision points are: Step 1: Gathering and analyzing system requirements; Step 2: Developing functional requirements; Step 3: Deciding on in-house development or outsourcing; Step 4: Developing technical requirements; Step 5: Developing the software; Step 6: Integrating the system; Step 7: Testing and QA and Step 8: Deploying and launching the system. A brief description of each step is presented below.

## 7.1 Step 1: Gathering and Analyzing System Requirements

Before initiating software development, it is important to understand and clearly articulate what is being built, and to ensure that the system supports and is aligned with the objectives of the project. Gathering and analyzing system requirements is a critical first step in this process. Considerations in the requirements gathering process may include:

* Analyzing relevant regulation(s) and legislation that will inform the system’s functionality, and the applicability of those to various types of users.
* Consideration of anticipated regulatory changes that could impact the program: To ensure the system and requirements documents are as responsive as possible to the evolving regulatory environment, it is important to include information on potential changes, such as changing thresholds, additional sectors, additional gases, etc.
* Future linkages with other jurisdictions: Future linkages can be enabled by aligning GHG reporting program design decisions, e.g., sector definitions; reporting thresholds; level of reporting (facility- or source-level); similar data types and formats (UOMs), metrics, conversion factors; calculation methodologies, including values for default emission factors5 and GWPs; and, common standards for verification. These considerations can then feed into the requirements for the DRMS.
* Gathering input from relevant stakeholders: Surveying potential users of the system (e.g., regulators, reporters, verification bodies) on their needs and challenges can provide key inputs into system design.
* Research and analysis of similar systems: Analyzing similar systems can yield valuable information on a range of best practices and lessons learned from those with experience in DRMS.
* Assessing existing data systems for re-purposing: In some instances, it may be possible to leverage or re-purpose existing data management systems when building a new system. This may have several benefits, including lowering costs related to software development and licensing, potentially increasing speed to market, leveraging in-house capacity, and reducing the need for capacity-building among reporters (if they are already familiar with the system).
* Assessing data exchange and integration needs: In some cases, it may be desirable to build a data management system that can exchange data with another system, such as a non-GHG pollutant system or an energy management or fuel tracking system, which may already contain much of the data needed to produce GHG emissions inventories. DRMS will be built to allow for the automated exchange of data from these existing data sets via interchanges such as application programming interfaces (APIs), XML feeds, or other web services. In order for this exchange to be successful, it needs to be well defined from the outset. Failure to plan and define data exchanges may result in data appearing in the wrong field, data failing to reach the destination database, or a host of other data errors.
* Prototyping: Prototyping is the process of developing and testing initial screen shots, system appearance, user experience, or functionality with stakeholders to further refine the system requirements. Ideally, there will be several iterations of early prototyping and user feedback to inform subsequent decisions on the system’s functional requirements.

## 7.2 Step 2: Developing Functional Requirements

Once system requirements are gathered and analyzed, detailed functional requirements can be

developed. Defining the functional requirements of the DRMS in advance of development will yield a number of benefits, including: 1) helping to inform the “build” or “buy” decision on the development of the system, 2) reducing implementation risks. 3) lowering development costs, leading to the delivery of an end product that matches policy, user, and other requirements.

## 7.3 Step 3: Making the Decision on the type of system to be developed

The type of system to be put in place depends on the project objectives, the activities, the data generated, the reporting system envisaged and the frequency and the level of reporting. The system could be incorporated in the project monitoring and evaluation or built as a stand-alone system.

## 7.4 Step 4: Developing Technical Requirements

The technical requirements document/s will provide system developers guidance on system performance, architecture, hardware, software, security, and hosting. Technical requirements can also clarify processes related to software development, integration, testing, and

deployment.

## 7.5 Step 5: Developing the Software

While the functional requirements define what the software must do, software development itself

is a process comprised of several key steps. These include configuring an appropriate development

environment for the development team, developing a clear database architecture for the system, adhering to best practices to coding/programming the system, and developing the front end of the system to be consistent with the programs brand/style requirements.

## 7.6 Step 6: Integrating the System

System integration is the process of bringing together the various functional, user interface, and data components into one cohesive system. The technical requirements may include a concise written plan that defines how code produced by multiple developers will be integrated in the evolving system, taking into consideration version control management with source control software, frequency of internal releases where code is compiled and “pushed” to the test server should also be defined. it is important to commit to a release schedule in order to stay on time and on budget.

## 7.7 Step 7: Testing

The test of every scenario for each functional component on every major OS and every major browser version are critical to ensuring a functional system. Conducting testing throughout development minimizes the risk of error and to flag issues early on so that they can be addressed during development. Testing is the key to a smooth deployment, and that allowing adequate time for testing and subsequent redesign and fixes makes for a more successful release. The testing system tool will list all possible use-variations of a given function across different operating systems and browsers. Each of these variations is called a “test case.” The testing system tool includes manual test cases, to be carried out on a case-by-case basis by individual testers; as well as automated testing via scripts written by testing engineers, which can automatically and quickly conduct many test cases. testing system tool can be managed via spreadsheets or off-the-shelf test suite management applications.

## 7.8 Step 8: Deploying and Launching the System

Once the hosting provider is selected, production servers can be configured with the relevant

software stack (e.g., OS, database [DB], web). This is typically undertaken several weeks before

actual deployment to ensure that everything is working before the system itself is deployed. Actual

deployment consists of copying compiled files to the production server and installing the database.

A first-time install is often completed with a database back-up and restore. For subsequent releases, changes must be scripted using tools such as SQL Delta, which compare source and destination databases. Optimizing the release and deployment process based on lessons learned from the first deployment and documenting and automating the process where possible will help make the process more efficient, build institutional capacity and to remove the risk of human error.

# Providing support to and building the capacity of DRMS users

Providing support to and building the capacity of DRMS users are key to ensuring smooth reporting cycles and accurate data input. Available resources, reporting timeliness, and accuracy requirements are important considerations when determining the appropriate type and level of support and training activities.

## 8.1 User Support

Access to customer support for the DRMS is crucial for the primary users: reporters and verifiers. Support for verifiers and reporters could include addressing both system and policy questions. Common questions from reporters include:

* Do I have to report? If yes, what do I have to report?
* How do I correct a mistake within the system?
* How do I change the user who must input the data?
* How do I reset my password?

Other questions about data requirements and/or how to interpret the program requirements, such as: 1) I understand that I need to report this piece of data, but I don’t understand how to report it within the system, 2) my reported values are now under the threshold that is required for reporting. How can I disengage from the system? There are a number of mechanisms for addressing user questions and supporting their needs. Considerations for determining the type of support include the (a) complexity of regulations, (b) complexity of the DRMS, and (c) the available resources.

## 8.2 Help Desk

A help desk system will be provided to support the system users’ needs. It provides a central location for user inquiries, if necessary, can re-route the request to an appropriate point of contact. This type of dedicated support system is especially helpful for new or large programs, allowing for timely support, more in-depth discussion on user questions, and ongoing education.

## 8.3 Telephone and Email

Telephone, email, notifications, and online chat/secure messaging systems will also be utilized to address user questions and to disseminate important system-related communications. For example:

* A dedicated telephone number could be established and promoted, which could be accessed by staff who would then connect the user with the appropriate point of contact.
* A dedicated email address can be set up to which users can send questions. Emails can also be sent from the address to notify users of relevant news, such as the launch of a reporting cycle or system updates. An important consideration is whether resources are available to respond to email queries in a timely manner and setting an expectation among users accordingly.

If needed, customer service could be provided through a combination of telephone support (via a call center), email and an instant message system within the DRMS.

## 8.4 Website

The DRMS website can be an effective way to engage with users and communicate updates and new features, information, and help services. Updates can also be linked to an RSS feed, allowing users to have the updates pushed to them. The website can include instructions to guide users

through the registration and reporting process; guidance documents that support these processes, such as frequently asked questions (FAQs); training materials (including pre-recorded webinars); and relevant contact details if they require additional information. The website could be used extensively as a central repository for all information relating to the reporting program and DRMS

## 8.5 Training and capacity building for DRMS users

The development of guidelines and training materials for users is an important component of managing a successfully used of DRMS. The level of training required will likely be dictated by how familiar the users are with the system. Activities and materials may include:

* FAQs documents.
* System user guides/manuals by user type, with step-by-step instructions and associated screen shots.
* Tool tips and other in-application instructions.
* Training materials and sessions, which may include live or pre-recorded webinars, in-person sessions, and videos.

# Tools and data collection approaches

## 9.1 Data collection

DRMS has an in build systematic data collection approaches and tools that facilitate field data collection and uploading into the system. Systematic approaches are able to collect real time data and information from the field with minimum bias and the process of uploading is also straightforward. Data related to changes in landscapes are best collected using systematic approaches in such a way that it is possible to establish long-term and rigorous monitoring systems to monitor the status of natural resources in the landscape such as the change in land use/land cover. The ground-based methods are complemented with the use of remote sensing data to establish for instance relationships between aboveground vegetation and soil health. Remote sensing, in addition to assessing spatial data, allow for the establishment of monitoring systems at larger spatial scales.

## 9.2 Sample data to be collected under the IGREENFIN phase 1

**GHG emissions data**

DRMS used data collection and reporting are foundational to a wide variety of GHG policies, and

allow regulators and policy makers to meet or analyze progress toward stated policy objectives. Policy objectives may include improving national GHG inventories, emissions trading systems, carbon taxes, crediting approaches; energy and energy efficiency initiatives, energy consumption taxes, energy balance, emissions standards, carbon targets or commitments (e.g., NAMAs), and national and regional analyses.

**Ex-Ante Carbon-balance Tool (EX-ACT)**

The DRMS will support the implementation of EX-ACT by facilitating data collection for the various phases of its implementation. Whether data for parameterization/calibration or for running calculation, DRMS will upload the spreadsheet of each project or country to facilitate monitoring and reporting at various levels. An integrated DRMS and EX-ACT will strengthen the land-based accounting system that summarize all the data (tier 1 and tier 2) related to the estimated values of the five carbon pools: above ground biomass, below ground biomass, dead wood, litter and soil organic carbon, as well as estimated coefficients of CH4, N2O and selected other CO2 emissions. Then the derived values of carbon stocks, stock changes as well as CH4, N2O and CO2 emissions, which are the basis of the overall carbon-balance will be projected through digital dashboard.

**Electrification and renewable energy in rural communities**

Digital dashboard will also be created for each country to capture the net amount of renewable electricity delivered to each consumer connected to the project renewable electricity generation system(s). Data will be collected and uploaded on the monthly basis. Alternatively, the net amount of renewable electricity delivered to all the consumers connected to the project renewable electricity generation system(s) could be calculated and used for analyses. For solar photovoltaic electricity systems, the annual average value for availability will be obtained by assuming a conservative default value of twelve per cent for the annual average value for availability, or by calculating the annual average value for availability based on local site conditions and system characteristics. In the case where there are multiple electricity generation systems with different characteristics, the data collection, and the calculation will be done separately for each system and the weighted average value will be taken. In this case, sub system dashboards will be created for the various systems then the weighted average will be visualized in the country dashboard.

# Linking the various dashboard with the project geoportal

The project will also collect a range of spatial data that need to be analyzed and visualized for the benefits of the stakeholders. A geoportal will be created to establish the link between the spatial data and the various project databases in such a way that there is interaction between the various component of the project. The objectives of the geoportal are to 1) establish regional spatial data infrastructure that provides and integrates geographically-referenced data generated by project activities, various stakeholders, government agencies/offices, and the universities; 2) provide a customer-friendly portal 24/7 web/online access to spatial data; and 3) provide an ICT platform for collaboration, data and resource sharing, integration, transparency and resource optimization. The project geoportal will above all be a spatial database management system capable of managing localized data, and therefore capable of entering, storing and extracting, querying analyzing them, and finally visualize them in form of maps for interest of various users.

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