Annex 7
Technical specifications- Agroforestry

We use the template below to provide a technical specification for the project intervention: agroforestry.

These Agroforestry Specifications are based on the Agriculture and Forestry Carbon Benefit Assessment Methodology (PM001 and PU001), approved by Plan Vivo as a methodology that can be used in smallholder agriculture and community forestry projects that generate Plan Vivo Certificates (PVCs).

Project Intervention:	Agroforestry
Version:	1.0
Date Approved:	
Methodology:	PM001 Agriculture and Forestry Carbon Benefit Assessment Methodology
Modules/Tools:	Module PU001
Certificate Type(s):	fPVCs (to be transformed into rPVCs and vPVCs)

Applicability conditions

This technical specification was developed for the agroforestry intervention. We refer to §3.3.1 for a description of the project areas and to the sections below for a description of the baseline scenario.

The agroforestry intervention includes installing home orchards with mixed native and/or naturalised tree species and supporting smallholder farmers with agroforestry practices. This intervention provides numerous ecosystem services and benefits for smallholder farmers. The project works with the acronym RPPR (*je Reçois un arbre, je Plante, je Preserve, et je Reçois l'argent*, I receive a tree, I plant it, I preserve it, and I receive rewards) to make the project accessible for everyone. In addition to the individual agroforestry plots, the project also aims to set up communal gardens providing ecosystem services and benefits for the whole community. The communal gardens will be planted via two techniques: 1. Seedlings from nurseries 2. Direct seeding technique.

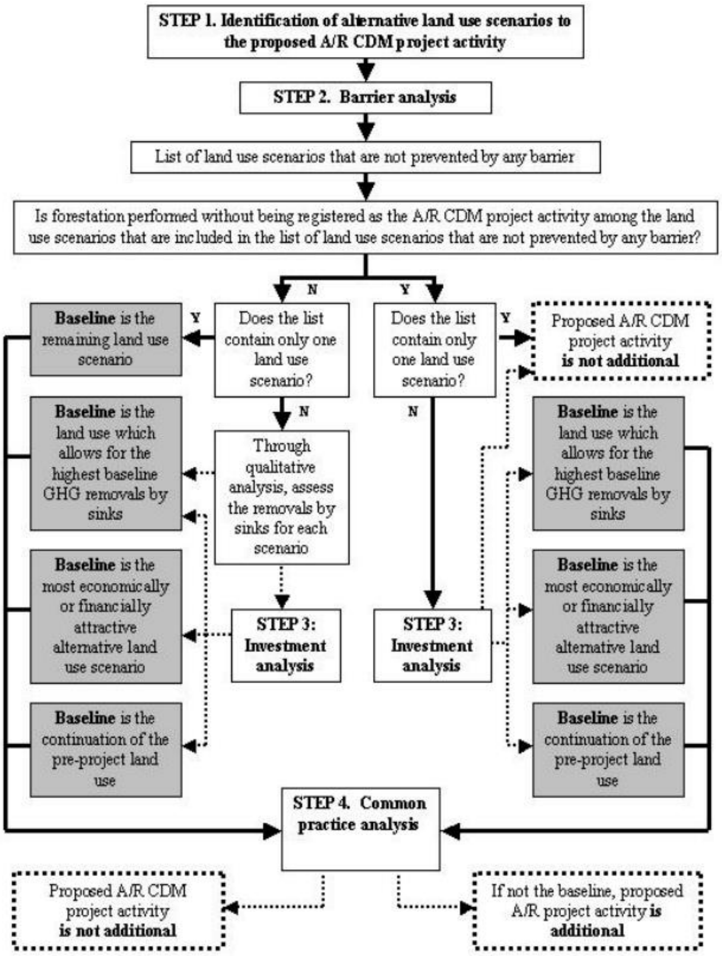
Using methodology PM001 and PU001 as tool, the project follows a strict checklist containing the project applicability conditions when considering a potential project area. All project areas must meet these requirements, while the checklist can also be used when identifying candidate plots for expanding the project. The applicability conditions for the project zones and potential expansion zones are:

i) Project activities do not include flood irrigation, drainage, or other activities that negatively affect the ground water table.
ii) Soil disturbance attributable to the project activity does not cover more than 10 percent of the area.
iii) The project activity does not lead to alteration of hydrology of the project area or hydrologically connected wetland areas unless this results from restoration of degraded wetlands by planting native species.
iv) The pre-project trees are neither harvested, nor cleared, nor removed by the project throughout the crediting period of the project activity.

v)	The pre-project trees do not suffer mortality because of competition from trees planted in the project, or damage because of implementation of the project activity, at any time during the crediting period of the project activity.The pre-project trees will be monitored alongside the other activities.
vi)	Community project areas in the Adamoua can only be located on plots of grasslands largely devoid of trees, with signs of bare soil, sheet or rill erosion. But plantings cannot be located on existing woodlands, nor on important or designated grazing lands.
vii)	Plantings must have firebreaks or other fire management techniques when relevant.
viii)	Farmers will protect the individual trees against grazing via a cage made of branches or other relevant techniques. The community will do the same via living fences or other relevant techniques.
ix)	Interested project participants require proof of land ownership that is consistent with the legislation (e.g. in the form of land title, purchase agreement, proof of inheritance, customary ownership, written confirmation on GPS coordinates of plot boundaries from the mayor, and other recognized authorities such as the traditional village chief).
x)	Observations of wildfire occurrence, overgrazing and tree cutting in and around the project areas must be reported by project staff and discussed during the yearly meetings with the communities.

Additionality

Below we describe the most likely land use scenario in the absence of project interventions and the additionality of the project interventions using AR-TOOL02 v1.0: "Combined tool to identify the baseline scenario and demonstrate additionality in A/R project activities".
We follow the following steps:



STEP 0. Preliminary screening based on the starting date of the project activity
The starting year of the activity was 2023. By then, the incentive from the planned Plan Vivo project was seriously considered in the decision to proceed with the project activity.

STEP 1. Identification of alternative land use scenarios to the proposed project activity
Sub-step 1a. Identify credible alternative land use scenarios to the proposed project activity
Based on the socioecological survey (see §3.3.1), we identify the following land use scenarios to be credible:
• Continuation of the pre-project slash-and burn activities in the community forests to create new agricultural and pastureland every year;
• Agroforestry (orchards and communal garden) on the plots within the project boundaries without being registered as a plan vivo project activity;

Slash-and burn or shifting cultivation involves clearing the space from its native vegetation in the dry season. The ash of the burned vegetation fertilises the soil, which is then prepared to plant in the wet season. These practices may cause some environmental concern, as this type of farming can cause soil erosion leading to leaching of nutrients, deforestation, and biodiversity loss[1]. Another drawback of shifting cultivation is the release of greenhouse gasses (CO_2, CO, CH_4, NO_x) into the atmosphere[2]. However, these practices still exist as they are an inexpensive way of preparing agricultural land[3].

According to the socioecological survey, all farmers use slash-and burn practices in order to create agricultural land or to create pastures. This phenomenon occurs once a year. Via an interview with an agro-economist, it was confirmed that farmers often create their fields that way, and after collecting their harvest, they clear another space to farm. The burning occurs in the dry seasons (December - March). The harvested area is left behind, with no efforts to reforest or enhance natural regeneration. This is consistent with the findings of van Vliet et al. (2012), who states that one of the drivers of slash-and burn agriculture is "the pressure to make a living particularly under conditions of inadequate resources often faced by farmers in the remote regions of the world". Often, they lack the manpower and machinery for this land clearing, what was confirmed during the interviews as people answered often with 'machinery' on the question what investment would help them. Along Tang et al. (2020)[4] it is likely that they will continue to practice the slash-and burn method until they encounter other sources of income.

Shifting cultivation has a direct impact on the biodiversity and soil. The fallow period is crucial for the minimisation of the soil degradation after burning. When the period is shortened, the soil does not have sufficient time to replenish with carbon and nutrients[4]. This again leads to soil degradation and consequently to lower agricultural yield and in addition a demand for more agricultural land. Complaints about the agricultural yield were common during the interviews in the project zone and even some of the farmers indicated a bad soil quality, which make them go further into the forest to create fields. In addition, studies show a decline in biodiversity in areas impacted by slash-and burn

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[1] van Vliet, N., Mertz, O., Heinimann, A., Langanke, T., Pascual, U., Schmook, B., Adams, C., Schmidt-Vogt, D., Messerli, P., Leisz, S., and Castella, J. C., 2012, Trends, drivers and impacts of changes in swidden cultivation in tropical forest-agriculture frontiers: A global assessment. Global Environmental Change, 22(2), 418–429. doi: https://doi.org/10.1016/j.gloenvcha.2011.10.009.

[2] Silva, J. M. N., Carreiras, J. M. B., Rosa, I., and Pereira, J. M. C., 2011, Greenhouse gas emissions from shifting cultivation in the tropics, including uncertainty and sensitivity analysis. Journal of Geophysical Research: Atmospheres, 116(D20). doi: 10.1029/2011JD016056.

[3] Ziegler, A. D., Bruun, T. B., Guardiola-Claramonte, M., Giambelluca, T. W., Lawrence, D., and Lam, N. T., 2009, Environmental consequences of the demise in swidden cultivation in montane mainland Southeast Asia: Hydrology and geomorphology, Human Ecology, 37(3), 361–373. doi: 10.1007/s10745-009-9258-x.

[4] Tang, K. H. D., & Yap, P. S. (2020, September). A systematic review of slash-and-burn agriculture as an obstacle to future-proofing climate change. In The Proceedings of The International Conference on Climate Change (Vol. 4, No. 1, pp. 1-19).

activities. As of last, this way of farming is not without health issues, as it contributes to air pollution and so can raise a public health concern.

It is important to highlight that slash-and-burn agricultural practices may not necessarily result in significant environmental damage. Typically, a limited area is cleared and subjected to controlled burning, often leaving some trees intact within the cleared space. Subsequently, during the cropping cycle, competitive perennial crops like bananas are cultivated, becoming the pioneer vegetation after the fields are eventually abandoned. Over a span of approximately two decades, these abandoned fields naturally transition into secondary forests. As time progresses, these secondary forests become indistinguishable from the primary forests[5].

Brown., (2006)[5] has indicated that slash-and-burn agriculture can be deemed sustainable when practiced within areas of low population density. This system is characterized by minimal inputs, as it necessitates no fertilizers and relies solely on manual tools for cultivation. However, as population density increases, the sustainability of this system becomes compromised due to shortened fallow periods. Although slash-and-burn practices are often viewed negatively, it is essential to recognize that this method expedites the conversion from primary forests to secondary forests without surpassing the regenerative capacity of the ecosystem. Lamb., (1997)[6] has even argued that the discontinuation of this system could potentially lead to a decline in biodiversity.

There are some alternatives to the slash-and burn activities among which agroforestry. Along Verchot et al. (2007)[7] this could be a good alternative due to its sustainability factors and adaptation capacity to climate change. Agroforestry systems contain many advantages such as improved water usage, increased soil productivity and nutrient usage, pest control and minimisation of diseases, enhanced crop yield, increased income, and carbon sequestration[8]. Kotto-Same et al. (1997) states that agroforestry as alternative land use could increase carbon storage by 75 t C ha^{-1} compared to slash-and burn practices and in addition add to biodiversity protection, poverty alleviation and deforestation deflection. However, there is a need for incentives and intervention to help farmers in adopting agroforestry practices[6].

Sub-step 1b. Consistency of credible alternative land use scenarios with enforced mandatory applicable laws and regulations

Both alternative land use scenarios are in compliance with mandatory legislation and regulations taking into account their enforcement in Cameroon. Continuation of the status quo is in agreement with laws and regulations, while spontaneous tree planting is obviously a land cover type that is allowed by applicable regulations on private lands.

STEP 2. Barrier analysis

Sub-step 2a. Identification of barriers that would prevent the implementation of at least one alternative land use scenarios

No financial, technical, institutional nor social barriers would plausibly hamper the continuation of the *status quo*. Continuation of the current landscape scenario requires no investments, technical knowledge nor legal efforts: croplands would remain croplands, and new agricultural land is created

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5 Brown, D. R. (2006). Personal preferences and intensification of land use: their impact on southern Cameroonian slash-and-burn agroforestry systems. *Agroforestry systems*, 68, 53-67.

6 Eyong, C. T. (2007). Indigenous knowledge and sustainable development in Africa: Case study on Central Africa. *Tribes and tribals*, *1*(1), 121-139.

7 Verchot, L. V., Van Noordwijk, M., Kandji, S., Tomich, T., Ong, C., Albrecht, A., Mackensen, J., Bantilan, C., Anupama, K.V . and Palm, C., 2007, Climate change: linking adaptation and mitigation through agroforestry. Mitigation and Adaptation Strategies for Global Change, 12(5), 901-918

8 Tang, K. H. D., & Yap, P. S. (2020, September). A systematic review of slash-and-burn agriculture as an obstacle to future-proofing climate change. In The Proceedings of The International Conference on Climate Change (Vol. 4, No. 1, pp. 1-19).

every year. However, agroforestry without extra funding is not a plausible scenario, given the significant amount of funding required and the lack of nurseries and technical knowhow in the area.

Sub-step 2b. Elimination of land use scenarios that are prevented by the identified barriers
We eliminate the scenario of agroforestry without extra funding, since it is not a plausible future land cover scenario, given the lack of antecedents, the significant amount of funding required and the lack of nurseries in the area. We refer to the financial plan (Annex 16).

Sub-step 2c. Determination of baseline scenario (if allowed by the barrier analysis)
Agroforestry without being registered as a plan vivo project is not included in the list of land use scenarios that are not prevented by any barrier. Consequently, only one land use scenario remains ("*slash-and burn activities for agricultural land creation"*), so according to the tool, this scenario is the baseline scenario. We continue with Step 4: Common practice test.

STEP 4. Common practice analysis
There are no similar previous or ongoing agroforestry activities in or near the project zones, not even remotely similar to this proposed plan vivo registered project. Consequently, the plan vivo project activity is not the baseline scenario and, hence, it is additional. The "*slash-and burn activities for agricultural land creation*" becomes the baseline scenario.

Finally, below we present a summary of the basic barriers the project activities are to overcome.

Table 1. Additionality Assessment Summary

Intervention Aspect	Main Barriers	Activities to Overcome Barriers
Financial/ Economic	- Limited funds - Lack of governmental or other nurseries - Other priorities - Limited public and private credit availabilities	- Start-up capital secured via Luxembourg Climate Fund; benefit sharing scheme supported by Plan Vivo - High-quality nursery established by the project - Free distribution of seedlings
Technical	-Direct seeding not applied in Cameroon before -Lack of governmental or other nurseries -Lack of fruit trees - Few trainings on agroforestry	Skilled local coordinator; academic input of environmental scientists; link with National Herbarium; installation of (agroforestry) nurseries and application of direct seeding
Institutional	"Top-down approach", although room is given for local initiatives	Bottom-up approach with first consultation rounds, continued workshops, strengthening of social cohesion via Plan Vivo assemblies, and benefit sharing for participating communities
Ecological	- Bushfires can affect tree growth	Plan Vivo maps as basis for community-based land management, fire management plan and enrichment planting of endemic and fruit species

Project activities

Agroforestry interventions include communal garden planting and home orchards with mixed native or naturalised species.

Agroforestry: Project Activities and Inputs

Agroforestry planting

1. **Establishing new nurseries (A2.1):** Near the village where project areas are located, a nursery will be established. These nurseries provide each 10 000 seedlings per year, which will be planted in the project zones. The endemic species are carefully chosen in collaboration with the community and smallholders (based on their needs). The mix of species can vary between project areas and type of planting zone (according to community demand). Seeds are collected by the Fes Enying team, supported by the National Herbarium, near the project area or in an area with similar ecological features as the project area. If there is a shortage of seeds, the team purchases the seeds on the market or via local seed producers and fruit sellers.

Figure 1: Example nurseries of Fes Enying in Mbandjock

The nurseries must be established close to water, on a flat site and in sight of the villagers. They are in open air but covered with palm leaves so the plants are not exposed with too much direct sun light, as in the dry season, the sun threatens to burn the young plants. These shades reduce the speed of the raindrops during the rainy season, thus cancelling out the effect of pummeling. The seeds can be treated in different ways before being planted in the pots (2 weeks in humid sand, soaking in lukewarm water for 2 hours, planting directly, …). The seedlings are planted in plastic pots with a size adapted to the plant species. The pots contain earth enriched with chicken manure compost or plant compost. The seedlings stay in the nurseries for minimum 4 months to maximum 8 months, depending on the plant species.

2. **Seed treatment for direct seeding (A1.1):** Seeds, destined for direct seeding in communal gardens, receive an appropriate treatment to break their dormancy before putting them directly into the ground. Several treatments rely on soaking and boiling the seeds, but as every seed is unique, there are many more types of treatments:

   Dépulpage: seeds with rapid germination pulp, removing the skin of the seeds having an envelope.
   Dépulpage + drying: seeds with slow-germinating pulps. The drying process occurs outside in the sun.
   Décorticage: removing the shell of the seed.
   Désailage: removing the wings of butterfly-shaped seeds.
   Soaking in lukewarm water

Burning

Soaking in cold water: dependent on tree species, this is for 12h, 24h or 48h.

Fermentation: it causes the germination of the cola from the 6th month of fermentation.

3. **Free seedling distribution (A1.2 & A2.2):** Every year, once these tree seedlings are mature enough, they are distributed for free to the project participants. They are transported to their planting ground in various ways. These seedlings benefit the surrounding community, amongst others by providing fruits and covering daily needs and in addition help to restore the ecosystem in degraded areas.








4. **Communal garden planting (A1.2)**: Planting of trees to create communal gardens is done on community land, after a plan vivo agreement is made with the Plan Vivo committees, the traditional chief and the mayor (see Annex 12a in the PDD). A mix of forestry and fruit trees will be planted to benefit both the community and the ecosystem. Two types of planting will be used, being 1. Direct seeding & 2. Seedlings (from nurseries) planting.

   1. Direct Seeding: After their treatment, the seeds are planted at a depth of 2 to 3 cm and covered with a thin layer of soil. This technique allows you to seed vast areas in a short time frame. In 2023, different test areas were sown with different tree species, proving the technique was successful (more information in the last direct seeding report Annex 2). The survival rate of the planted seed is 50%.

   2. Seedling from nurseries: The seedlings are planted in a hole (ø 25cm, depth 35cm). Fruit trees are planted at a distance of 7 to 10m of each other. The survival rate for planted seedlings is about 50% after 1 year. In any case, the project aims at a final stand density of 200 trees/ha. To achieve the stand density target, regarnissage/ replenishment planting is performed in the year after planting (when relevant and after

survival rate counting). Every year, more and more areas form the focus of planting, and regarnissage/replenishment is foreseen regularly to obtain the minimum density. The communities led by Plan Vivo committees are helping with protecting and observing the project zone.

The five principal species for communal gardens planting can be found in the table below (but note that other endemic tree species may be planted as well). Dependent on the species, they can be planted by direct seeding (e.g. Njanssang) or via seedlings.

Common name	**Scientific name**	**Benefits**
Neem tree	Azadirachta indica	Extraction of neem oil, medical use
Quatre côtés	Tetrapleura tetraptera	spices and cures stomach ache
Njanssang	Ricinodendron heudelotii	Nutrition and medicinal use
Bita kola	Garcinia Kola	The nuts are eaten
Moringa	Moringa oleifera	Medical use

5. **Home orchard planting (A2.2):** Planting of trees is done on individual fields, after a plan vivo agreement is made (see Annex 12b). The seedlings are eventually planted in a hole (diameter 25cm) and depth 35cm, at a distance from 7 to 10m. Through tree planting, at least 200 trees are planted per hectare. The survival rate for planted seedlings is about 60% after 1 year. In any case, the project aims at a final stand density to 200 trees/ha. To achieve the stand density target, regarnissage"/replenishment planting is performed in the year after planting (when relevant and after survival rate counting). The agroforestry model allows farmers to continue with crop planting in between the fruit trees, so food security is maintained. All farmers can receive free agroforestry training, which should help the farmers in successfully maintain the trees. The five principal species asked for this type of planting can be found in the table below. It should be noted that other tree species can be planted as well.

Common name	**Scientific name**	**Benefits**
Avocado	Persea Americana	Nutrition and trading
Orange	Citrus sinensis	Nutrition and trading
Mandarin	Citrus reticulata	Nutrition and trading
Lemon	Citrus limon	Nutrition and trading
Mango	Mangifera indica	Nutrition and trading
Safoutier	Dacryodes edulis	Nutrition, medical and shade tree for coffee or cacao plantation.

6. **Installing firebreaks (A1.3 & A2.5):** The project helps to protect and restore degraded ecosystem areas. The establishment of a fire management plan (see annex 20 in the PDD) based on prevention – treatment – evaluation is a key element. The plan includes ao firebreaks to protect seedlings from runaway fire (where appropriate). The project actively creates effective firebreaks, in close consultation with the communities of the villages. The firebreaks will have a width of 10 to 15m for the communal gardens, dependent on the plants chosen as living fence. The project equally creates awareness among communities about fire prevention strategies.

7. **Protection against grazing (A1.4 & A2.5)**: Individual farmers will be encouraged to

protect their trees by building small wooden cages for the seedlings in order to avoid livestock eating the trees. The communal garden will be protected in a first phase with an artificial fence while plants forming a living fence are planted around the communal gardens in order to protect them against livestock.

8. **Aftercare (A2.4):** Both the project team of Fes Enying and the communities are responsible for the aftercare. Free training on aftercare management is provided. Trees can be protected from drought by mulching and irrigation. Trees are protected from fire by firebreaks and other fire management techniques when relevant. Pruning and selective felling (as long as the end density is maintained) is permitted. Besides, post-planting aftercare is safeguarded using the milestone-based monitoring scheme for both communal gardens & home orchards (see §Monitoring).

Benefits

9. **Activate ecosystem co-benefits (A3 & A4.1)**. Communal garden planting and stimulation of agroforestry in the project zone is important to enhance the biodiversity and preserve the forest in community forests, as slash-and burn practices will be reduced. Non-timber forest products still have a high value for the people as additional products to their diet, as natural medicine or to sell on the market. Besides, the project will monitor *biodiversity* in a quantitative way, including key flora species, using the Shannon diversity index. The monitoring program will be established.

10. **Involve the community (A4.1 & A4.2)**. The local communities will be involved in each step of the project and will be activated in the project as co-designers, maintaining the nurseries and planting trees for the communal garden, and the individual plots. Workshops for agroforestry practices by smallholder farmers and the communities are held as well.

11. **Activate community re-investments (A4.3)**. There are many socio-ecological challenges that could be supported by the plan vivo re-investments at the decision of the communities. Examples are to improve water accessibility by installing wells, to improve children's access to school, to improve the marketing channels for non-timber forest products, etc. We refer to the PES-agreement for the framework of the re-investments.

Carbon benefits

Crediting Period

The project start date was June 2023. The period of time over which the climate benefits are quantified is 30 years.
Direct payments will be made to all individual smallholder participants during the first 15 years of the project period, in line with the achievement of the milestone targets. This allows to cover the early costs of planting the seedlings and taking care of these during the first years. Meanwhile, the payments also support the participating individual smallholders with cash to meet their direct livelihood needs. After 15 years, smallholders will also benefit from the non-timber forest production and ecosystem benefits. Payments for the village, coming from the communal gardens are made during the first 10 years of the project. After 10 years, it is expected that the communal garden will provide the community with fruits and non-timber forest products.

Carbon Pools and Emission Sources

These technical specifications are developed using Module PU001. We include the following carbon pools (Table 2):

Pools or emission sources	Type of pool or emission source	Included + justification/explanation
Carbon pools	Soil organic carbon	**Yes**: This pool is affected by tree planting, agroforestry and agricultural activities.
	Above-ground biomass	**Yes**: above-ground biomass (trees) is a major pool for carbon sequestration, to be considered for tree planting and agroforestry activities.
	Below-ground biomass	**Yes**: this is a potentially significant pool and is considered for tree planting and agroforestry activities.
	Non-tree biomass	No: Non-tree biomass and grasses are not included as carbon pools in the above-ground biomass estimations.
	Dead wood and litter	No: Dead wood and litter are not explicitly included in the accounting.
	Wood products	No: Wood products are not accounted for and are conservatively excluded.

This intervention is targeting plots that are currently largely devoid of trees or subjected to periodic cycles (e.g. slash-and-burn, or clearing regrowing cycles [or periodic burning]). It is assumed that the current woody biomass stock on the plots would remain static under both the baseline scenario and under the project intervention scenario. Indeed, given among others the lack of nurseries in the region, it is highly unlikely that smallholders would independently plant trees on their plots without extra project support.

Baseline Emissions/Removals

Currently, the project areas for agroforestry activities in the project zone are largely devoid of trees or subjected to periodic cycles. Without improved management and woodlot planting, we expect a stable system where future carbon sequestration will be very limited.

The tree cover trends in Cameroon are worrying, as the country took place 7 in the world's top deforesters in 2021 (World Bank Group., 2022). Between 2001 and 2020, about 1.53 million ha of forest was lost, with clearing for agriculture space as principal cause[9]. In Mayo-Banyo the prevailing forest type is wooded savannah (Awé, D. et al., 2021[10]). Currently, there is no social structure that helps protecting the forest, so illegal logging occurs in the region, which causes degradation of the wooded savannah (Figure 2). In this region, land is mainly used for agricultural activities by the sedentary farmers. However, cattle is an important livelihood feature, so large land fractions are also used for grazing. Next to that, semi-nomadic people (Mbororo) need space for their own cattle to graze, and they may burn areas to improve the growth of fresh herbs for their cattle.

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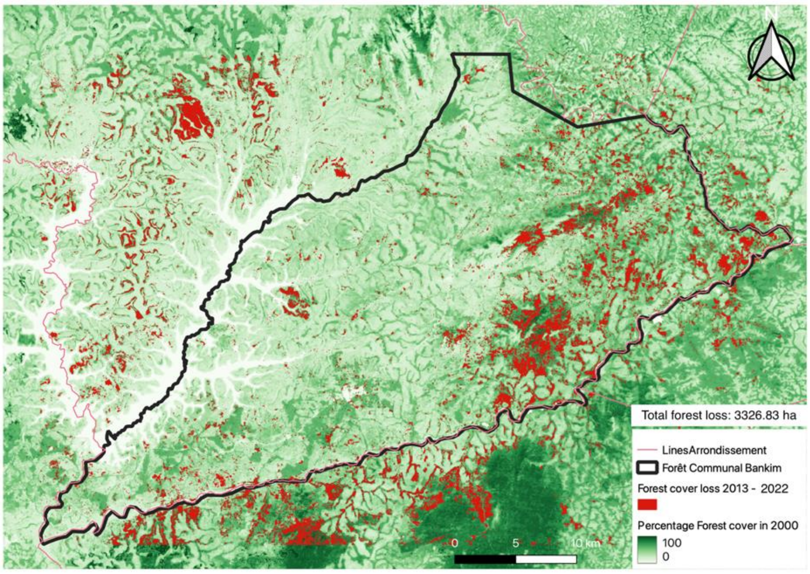
[9] World Bank Group. 2022. Cameroon Country Climate and Development Report. CCDR Series;. © World Bank, Washington, DC. http://hdl.handle.net/10986/38242 License: CC BY-NC-ND."

[10] Awé, D. V., Noiha, N. V., & Zapfack, L. (2021). Carbon management for savannah ecosystems in Central Africa: a case study from Cameroon. *International Journal of Low-Carbon Technologies*, *16*(4), 1290-1298

Figure 2: Landscape view of Bankim area

Between 2015 and 2022, Mayo-Banyo lost 10 100 ha of tree cover, with the largest loss in 2022 (2070 ha)[11]. More specific, in the start project area Bankim, we checked the historical deforestation rates. The estimation of the deforestation rate is based on the communal forest of Bankim between 2013 - 2022. The polygon of this area is retrieved from the official site of the MINFOF[12]. As the plan vivo methodology is followed for the estimation of the deforestation, the dataset of Hansen et al. (2013)[13], was explored in Google Earth Engine. The layers are built with Landsat 7 images, with a resolution of 30 x 30m. The first layer was made with the forest cover in 2000, which is defined as canopy closure for all vegetation taller than 5m. Every pixel has a value between 0 and 100, pointing out the percentage of forest cover. The layer above the forest cover is the forest cover loss layer. Forest cover loss is defined as the complete removal of the tree canopy, so 0% tree cover. The forest cover loss is derived from both the annual decline in the percentage of tree cover and the normalized difference vegetation index (NDVI) during the minimum growing season.

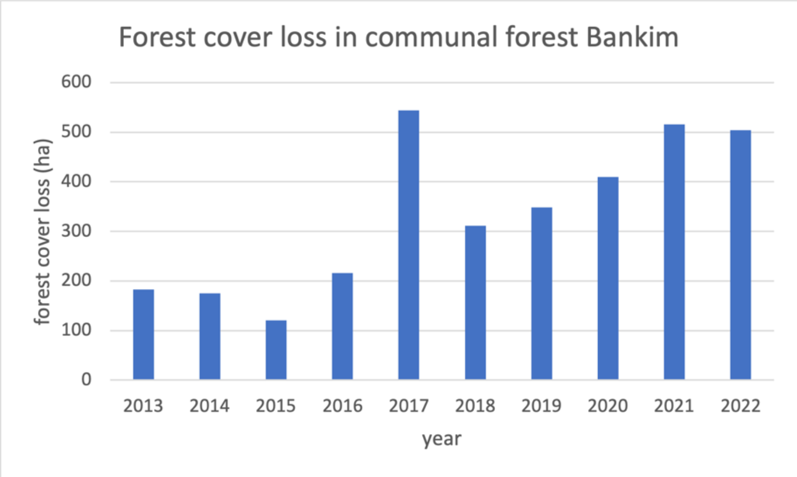
Deforestation was investigated during 2013 – 2022, and the total area lost in the specific period is displayed on the map below. The annual loss in tree cover area can be examined in the graph by the map, and the percentage of tree cover loss was calculated for this specific timeframe.



11 https://gfw.global/3ZHXGBm

12 https://data-minfof.opendata.arcgis.com/search?collection=Dataset

13 Hansen, M. C., P. V. Potapov, R. Moore, M. Hancher, S. A. Turubanova, A. Tyukavina, D. Thau, S. V. Stehman, S. J. Goetz, T. R. Loveland, A. Kommareddy, A. Egorov, L. Chini, C. O. Justice, and J. R. G. Townshend. 2013. "High-Resolution Global Maps of 21st-Century Forest Cover Change." Science 342 (15 November): 850–53. Data available on-line from:https://glad.earthengine.app/view/global-forest-change.



There is a vast forest area loss in absolute numbers in Bankim (in percentage 3.6% since 2013). Without active nurseries, distribution of seedlings, investment funding, planting and training on management techniques, we can expect a stable or even declining baseline where future carbon stocks will not increase and even decrease. It is highly unlikely that farmers will voluntarily plant trees on the plots without the support of the project (nurseries, trainings, …). Overall, we can reasonably assume that there is no change in carbon stock in the baseline scenario as compared to the initial carbon stock: ΔCbaseline = 0. Given the negative trends in tree coverage, this is a conservative assumption.

Following the Plan Vivo PU001 module, there is "no change in woody biomass carbon stocks if the conditions in AR-TOOL14 v4.2 section 5 are met". This tool states 'conditions under which carbon stock and change in carbon stock may be estimated as zero', which are the following:

1. The pre-project trees are neither harvested, nor cleared, nor removed by the project throughout the crediting period of the project activity;
2. The pre-project trees do not suffer mortality because of competition from trees planted in the project, or damage because of implementation of the project activity, at any time during the crediting period of the project activity;
3. The pre-project trees are not inventoried along with the project trees in monitoring of carbon stocks but their continued existence, consistent with the baseline scenario, is monitored throughout the crediting period of the project activity.

The above conditions are met in all project zones and in addition:

"Changes in carbon stocks in trees and shrubs in the baseline may be accounted as zero for those lands for which the project participants can demonstrate, through documentary evidence or through participatory rural appraisal (PRA), that one or more of the following indicators apply:

i. Observed reduction in topsoil depth (e.g. as shown by root exposure, presence of pedestals, exposed sub-soil horizons);
ii. Presence of gully, sheet or rill erosion; or landslides, or other forms of mass movement erosion;
iii. Presence of plant species locally known to be indicators of infertile land;
iv. Land comprises of bare sand dunes, or other bare lands;
v. Land contains contaminated soils, mine spoils, or highly alkaline or saline soils;
vi. Land is subjected to periodic cycles (e.g. slash-and-burn, or clearing regrowing cycles [or periodic burning], see pictures below) so that the biomass oscillates between a minimum and a maximum value in the baseline.

We note that the above underlined conditions are valid and safeguarded as project applicability conditions.

Figure 3: Examples of land subjected to sslash-and burn periodic cycles in Bankim

Expected Project Emissions/Removals

Expected changes in carbon are calculated based on PU001 through AR-TOOL14: Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities, Version 4.2.

At project start, expected project removals in woody biomass must be estimated through the modelling of tree growth development following the procedures in AR-TOOL14 v4.2 Section 8.2. That method is used for ex-ante estimation (initial projection) of carbon stock in tree biomass. One must develop a fitting growth model to predict the growth of trees and the development of the tree stand over time. To develop the growth model, DBH growth curves of the main species involved were obtained from literature and field measurements.

For the avocado and mango tree, no accurate DBH growth curve could be found in literature. Measured growth files from Ethiopia were used to have an appropriate estimate of the growth curve. As Ethiopia has a drier climate than Cameroon, it is considered that these growth files are conservative.

The field measurements were compared with the literature data and the slowest growth curves were retained for further calculations, after expert judgement, the growth curves were corrected with 7% (see annex 6).

Kearsley et al. (2017)[14] used the pan-tropical model by Chave et. al (2014) to model the AGB per tree:

$$AGB = 0.0673 \cdot (\rho \cdot D^2 \cdot H)^{0.976}$$

Where H was estimated based on the formula in Chave et. al (2014) using E, the environmental stress factor.

$$ln\ H\ = 0.893 - E + 0.760\ ln\ D - 0.034D)\ ^2$$

Where E = 0.1595973 was retrieved via R from the publicly available raster on http://chave.ups-tlse.fr/pantropical_allometry.htm.

[14] Kearsley, E., Moonen, P. C., Hufkens, K., Doetterl, S., Lisingo, J., Boyemba Bosela, F., ... & Verbeeck, H. (2017). Model performance of tree height-diameter relationships in the central Congo Basin. *Annals of Forest Science*, *74*, 1-13.

However, the formula for tree height does not take into account the different maximum tree heights. Therefore, when a tree species reaches its average height within the modelled 30y of the project, the further calculations are executed with the average height. The maximum height was retrieved from several databases and studies (see Annex 6).

Wood densities are determined from several databases[15] and studies (see Annex 6). Based on the allometric equation above, above-ground carbon content was estimated per tree as 0.475 × AGB (Awé et al., 2021)[16]).

Zekeng et al.[17] stated that trees with a DBH < 5cm do have a root shoot ratio of 0,320 and > 5cm 0,235. For reasons of conservativeness, we take the lowest root shoot ratio of 0,235 to estimate the below ground woody biomass (BGB).

$$BGB = 0.235 \cdot AGB$$

The soil organic carbon is estimated using AR-TOOL16: Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities. The tool states in §11: "Considering uncertainties and inherent limitation of the precision of a factor-based estimation used in this tool, value of the rate of change of SOC stock is not accounted as more than 0.8 t C ha^{-1} yr^{-1}`". Soil carbon stocks measurements in cocoa agroforestry systems in Cameroon indeed show an increase of 0.98 t C ha^{-1} yr^{-1} (Silatsa et al., 2017)[18]. Along Vågen et al. (2015)[19] the conversion of cultivated land to agroforestry in tropical savanna areas can yield in a SOC increase up to 5.3 t C ha^{-1} yr^{-1}.

The value of 0.8 t C ha^{-1} yr^{-1} is used as soil sequestration rate, which is, considered the studies above, a conservative estimation.

Potential Leakage

Leakage is defined as a reduction in carbon stocks or increase in greenhouse gas emissions outside the project area, as a result of project activities. On the croplands, cropping agriculture can continue as before. Yet, the main potential source of agroforestry leakage in Bankim would clearly come from displaced grazing, i.e. Mbororo burning pressure displaced towards other nearby areas because grazing is no longer possible inside the project areas.

This technical specification uses AR-TOOL15 version 2.0 to estimate leakage significance: A/R Methodological tool – Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity. The tool states under §10: "Leakage emission attributable to the displacement of grazing activities under the following conditions is considered insignificant and hence accounted as zero (applicable conditions are underlined):

15 Species | My Tropical Timber. (z.d.). My Tropical Timber. https://www.mytropicaltimber.org/en/products; Cameroun. (z.d.). http://www.cesbc.org/economie_forestiere/Afrique/Cameroun/Indicateurs_forestiers/essences_forestieres_exploitables_cmr.htm; ICRAF Database - Wood density. (z.d.). http://db.worldagroforestry.org//wd/genus/Microberlinia.

16 Awé, D. V., Noiha, N. V., & Zapfack, L. (2021). Carbon management for savannah ecosystems in Central Africa: a case study from Cameroon. The International Journal Of Low Carbon Technologies, 16(4), 1290–1298. https://doi.org/10.1093/ijlct/ctab050

17 Zekeng, J. C., Van Der Sande, M. T., Fobane, J. L., Mphinyane, W. N., Sebego, R., & Mbolo, M. M. A. (2020). Partitioning main carbon pools in a semi-deciduous rainforest in eastern Cameroon. Forest Ecology and Management, 457, 117686. https://doi.org/10.1016/j.foreco.2019.117686

18 Silatsa, F. B., Yemefack, M., Ewane-Nonga, N., Kemga, A., & Hanna, R. (2017). Modeling carbon stock dynamics under fallow and cocoa agroforest systems in the shifting agricultural landscape of Central Cameroon. Agroforestry systems, 91, 993-1006.

19 Vågen, T. G., Lal, R., & Singh, B. R. (2005). Soil carbon sequestration in sub-Saharan Africa: a review. Land degradation & development, 16(1), 53-71.

(a) Animals are displaced to existing grazing land and the total number of animals in the receiving grazing land (displaced and existing) does not exceed the carrying capacity of the grazing land;
(b) Animals are displaced to existing non-grazing grassland and the total number of animals displaced does not exceed the carrying capacity of the receiving grassland;
(c) Animals are displaced to cropland that has been abandoned within the last five years;
(d) Animals are displaced to forested lands, and no clearance of trees, or decrease in crown cover of trees and shrubs, occurs due to the displaced animals;
(e) Animals are displaced to zero-grazing system.

Observations of leakage are discussed during the annual community meetings and included in the annual monitoring targets (see §4) and the current project areas cannot be important or designated grazing lands. A statement of a government official must be made to confirm the location of the grazing lands to where cattle can be displaced, as well as the fact that these grazing lands are not under significant pressure. If relevant for Mbororo, this decision must be made in close consultation with the Ardos.

Above conditions are safeguarded as applicability conditions: the leakage risk from displaced grazing is insignificant.

We estimate that the risk of displacement of agricultural activities is negligible. Smallholder farmers could hypothetically compensate the lost space (because of tree planting) on their agricultural field with slash-and burn activities on new fields. However, agroforestry is a complementary activity to their crop farming and will make their lands more productive (one of the key advantages of agroforestry[20]), so no yield will be lost. At the start of the project, the individual smallholders will receive a large percentage of the benefits according to the monitoring plan to compensate for the first years where the trees do not give NTFPs yet. With these arguments, we can reasonably state that the risk of leakage is negligible and leakage losses may be considered zero. However, leakage will be monitored, using E5 in PDD.

Uncertainty

We refer to AR-Tool14, which states in §8.2: "Ex-ante estimation (projection) of carbon stock in tree biomass is not subjected to uncertainty control, although the project participants should use the best available data and models that apply to the project site and the tree species". It is therefore not necessary to control for uncertainty estimation as described in PU005.

Expected Carbon Benefits

In the Tables below we provide an overview of the expected carbon benefits and the Plan Vivo Certificate Potential.

Table 3.8a Expected Carbon Benefits Summary

Project Intervention	Initial carbon stock (tCO2e/ha)	Baseline Emissions (t CO2e/ha)	Project Emissions (t CO2e/ha)	Leakage Emissions (t CO2e/ha)	Carbon Benefit (t CO2e/ha)
Home orchard Bankim	0	0	255.4	0	255.4
Communal garden Bankim	0	0	247.1	0	247.1

20 Nyong, A. P., Ngankam, T. M., & Felicite, T. L. (2020). Enhancement of resilience to climate variability and change through agroforestry practices in smallholder farming systems in Cameroon. Agroforestry Systems, 94, 687-705.

Table 3.8b Plan Vivo Certificate Potential

Project Intervention	Carbon Benefit (t CO2e/ha)	Project Area (ha)	Total Carbon Benefit (t CO2e)	Risk Buffer (t CO2e/ha)	Potential PVCs (t CO2e)
Home orchard Bankim	255.4	9.77	2495.3	51.1	1 996
Communal garden Bankim	247.1	6.4	1573.9	49.4	1 259
TOTAL	502.5	16.17	5 643.1	100.5	3 255

Monitoring

The project will rigorously keep track of the performance of each project plot over time. Each plot has a project agreement with a plan vivo map, along with a monitoring scheme specifying the performance-based milestones. Note that the pre-project trees are not inventoried along with the project trees in monitoring of carbon stocks but their continued existence, consistent with the baseline scenario, is monitored throughout the crediting period of the project activity.

Milestone-based monitoring scheme for each the home orchard plots:

Time of measurement (yr)	Performance-based milestone	Method of measurement	Payment per hectare
0	At least 50% of the planned number of trees is planted and protected against fires if relevant, while geographic coordinates and DBH of all existing trees on the plot are recorded.	Physical counting of all trees.	20%
1	At least 100% of the planned number of trees is planted and protected against fires if relevant	Physical counting of all new trees planted	20%
3	At least 80% of the planned trees survived	Physical counting of all new trees planted	20%
5	Average DBH of at least 6cm	DBH measurements based on a representative sample of at least 10% of the trees concerned	20%
7	Average DBH of at least 8.5cm	DBH measurements based on a representative sample of at least 10% of the trees concerned	10%

9	Average DBH of at least 10.5cm	DBH measurements based on a representative sample of at least 10% of the trees concerned	4%
12	Average DBH of at least 13.5cm	DBH measurements based on a representative sample of at least 10% of the trees concerned	3%
15	Average DBH of at least 16.5cm	DBH measurements based on a representative sample of at least 10% of the trees concerned	3%

Milestone-based monitoring scheme for each the communal garden plots:

Time of measurement (yr)	Performance-based milestone	Method of measurement	Payment per hectare
0	At least 50% of the planned number of trees is planted and protected against fires if relevant, while geographic coordinates and DBH of all existing trees on the plot are recorded.	Physical counting of all trees.	20%
1	At least 100% of the planned number of trees is planted and protected against fires if relevant	Physical counting of all new trees planted	20%
3	At least 80% of the planned trees survived	Physical counting of all new trees planted	30%
5	Average DBH of at least 5cm	DBH measurements based on a representative sample of at least 10% of the trees concerned	10%
7	Average DBH of at least 7cm	DBH measurements based on a representative sample of at least 10% of the trees concerned	10%

10	Average DBH of at least 10cm	DBH measurements based on a representative sample of at least 10% of the trees concerned	10%

It is important to note that *all* project plots (communal gardens and home orchards) are visited by project staff or by a member of the Plan Vivo committees in the years specified in the Monitoring Table.

At the first three milestone checks, all planted trees are observed (to count the number planted and the survival rate). At the last milestone checks, diameter at breast height is measured for every project plot at a representative subpopulation of that plot (subpopulation equal to minimal 10% of the total planted trees in the project plot). The subpopulation of 10% of the planted trees is sampled during linear transect walks crossing the project plot and recording every tree encountered (until the 10% target is obtained). Alongside DBH measurements, species, number of trees and health status are recorded as well.

The project customized a QField application to oversee and manage the large amount of data that are generated. Every farmer is registered in the app, together with his individual agreement and his field is saved as a shapefile in the app. The tree species and number which he/she planted are registered. Every milestone year, a member of the Fes Enying team or Plan Vivo committees will come and check if the target is reached. If an anomaly is detected, this is registered as well in the app. The same approach is used for the communal gardens. The surface is registered in the app. The sprouts after 6 months via direct seeding and seedlings planted are registered. Every milestone year it is checked if the targets are reached.

The use of funds acquired from agroforestry plots will be divided into two broad categories. 40% will go to program operations and development whereas the remaining 60% will go into a separate Trust Fund. This fund is effectively a distinct account earmarked for payments to smallholder producers. These funds will be distributed periodically over a fiftheen-year period based on the milestones above. Prior to disbursement, the money will be kept in the trust fund and the interest will be used to cover the financial transaction fees of paying the producers. From the 60% partim smallholder farmers receive, 10% is shared with the community as a Community Fund. 60% of the funds acquired from the communal garden is to be shared with the community as well in this Community fund (see benefit sharing mechanism).