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PROYECTO DE CARBONO FORESTAL VICHADA ALIANZA FIDUCIARIA S.A.

Document prepared by:

bd Forestales Consultoría

Alianza Fiduciaria S.A.

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MONITORING REPORT	
Name of the project	Proyecto de Carbono Forestal Vichada Alianza Fiduciaria S.A.
BCR Project ID	BCR-CO-139-14-001
Registration date of the project activity	24/02/2022
Project holder	Alianza Fiduciaria S.A.-Fideicomiso

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MONITORING REPORT	
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MONITORING REPORT	
Version number of the Project Document applicable to this monitoring report	3.1
Applied Methodology	METHODOLOGICAL DOCUMENT. AFOLU SECTOR. BCR0001 Quantification of GHG Emission Reductions. GHG REMOVAL ACTIVITIES. Version 4.0
Project location (Country, Region, City)	Colombia, Vichada, La Primavera.
Project starting date	01/01/2018
Quantification period of GHG emissions reduction	01/01/2018 – 31/12/2019
Monitoring period number	First monitoring period
Monitoring period	01/01/2018 – 31/12/2019
Amount of emission reductions or removals achieved by the project in this monitoring period	During the first monitoring period it were generated a total GHG reductions of 29,508 tCO2 eq. With an average of 14,754 tCO2 eq./year.
Contribution to Sustainable Development Goals	SDGs 8, 12, 13 and 15

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Special category, related to co-benefits N/A

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1 General description of project

The Forest Carbon proposal, represented by Alianza Fiduciaria S.A. as spokesperson for the autonomous Patrimonies trust Galicia y Andalucía, aims to establish a reforestation project with commercial forest species in the municipality of La Primavera (department of Vichada, in the eastern plains of Colombia), which aims, among other objectives, at fixing atmospheric carbon through the growth and development of plantations.

This environmental initiative not only contributes to global greenhouse gas reduction goals, but also stimulates both the international carbon market and local markets driven by fossil fuel consumption policies. Through the acquisition and legal ownership of land previously used for extensive grazing and slash-and-burn agriculture, the project aims to protect ecosystems and ecologically important areas and combat land degradation caused by unsustainable practices. By transitioning from extensive cattle grazing to stopping grassland burning, the project aims to harness the region's agro-ecological potential while addressing challenges such as inadequate infrastructure and labor for forest production systems. Overcoming these hurdles will require the use of species with specialized adaptive capacities and the application of proven technology packages for land-use change processes, from the restoration of degraded soils to the establishment of new forests for commercial or ecological purposes.

The commercial forest specie considered for the development of reforestation actions is *Pinus caribaea*, with an intervention area of 1,641.70 hectares, of the 1,645.85 eligible hectares of properties on which the project is developed. In this area, in accordance with the company's environmental regulations, withdrawals to water sources have been left, allowing the existing gallery forest could be protected, its area increased and coupled with the commercial forest units that form connecting corridors, especially for fauna.

In this way, it is expected that the forest will resemble the native forests of the region in structure and species composition, promoting the movement of fauna between ecosystems and ensuring the protection of environmental services important to the region, such as water, and together with the commercial areas, contributing to improving the chemical and physical conditions of the soil to activate a sustainable agroecology and contribute to the mitigation of global climate change. On the other hand, the timeline, the start date of the project initiative is January 01, 2018 (Annex: Section 3 - Quantification of GHG emissions reduction/Start date).

The project's monitoring period from 01/01/2018 to 31/12/2019 yielded impressive results, generating 29,508 tCO_2 GHG removals and 23,607 tCO_2 as carbon credits from ARR activities across various sinks such as above-ground and below-ground biomass, soil organic carbon, shrubs, leaf litter, and dead wood on soil. Notably, native shrubs

play a significant role in biomass area within plantations, remaining for several years before interventions. Moreover, the project aligns with Sustainable Development Goals 8, 12, 13, and 15, benefiting both the local community and biodiversity while generating GHG removals. This initiative not only contributes to national climate change mitigation goals in agriculture but also enhances regional environmental conditions and soil productivity for future agricultural endeavors. Additionally, it enables project proponents to manage economic risks effectively by bolstering cash flows through the sale of carbon environmental services.

1.1 Sectoral scope and project type

The scope of the BCR Standard is limited to:	
The following greenhouse gases, included in the Kyoto Protocol: Carbon Dioxide (CO2), Methane (CH4) and Nitrous Oxide (N2O).	
GHG projects using a methodology developed or approved by BioCarbon Standard, applicable to GHG removal activities and REDD+ activities (AFOLU Sector).	
Quantifiable GHG emission reductions and/or removals generated by the implementation of GHG removal activities and/or REDD+ activities (AFOLU Sector).	X
GHG projects using a methodology developed or approved by BioCarbon Standard, applicable to activities in the energy, transportation and waste sectors.	
Quantifiable GHG emission reductions generated by the implementation of activities in the energy, transportation and waste sectors.	

1.2 Project start date

The Project start date is **January 01, 2018**, the date of purchase of the service of preparation and establishment of the plantation related to the afforestation activities of the project, in addition to renting the machinery needed to prepare the site. (Annex: Project_start_date.pdf).

1.3   Project quantification period

The time period for quantification of GHG emission removals is: January 01, 2018 - December 31, 2045 (30 years). Besides, the first monitoring period is from January 01, 2018, to December 31, 2019.

1.4   Project location and project boundaries

The project is located in the municipality of La Primavera (5°29'26 "N - 70°24'33 "W), in the department of Vichada in eastern Colombia (Figure 1), bordering Venezuela. Its distance from the country's capital, Bogotá, is close to 556 km.

The locations for the lots that are part of the project proposal are shown in Table 1 (see KML files in the annex: Section 2 - General description of the project\Location).

Table 1 – Coordinates of the properties where the project is located

Name	Point Center		Eligible Area (ha)[1]
	Latitude	Longitude	
Andalucía	5° 22' 44,966" N	69° 46' 32,373" W	818.91
Galicia	5° 23' 28,807" N	69° 45' 23,290" W	826.94
Total			*1,645.85*

[1] See annex: Section 1 - Project type and elegibility/Elegibility/Análisis de elegibilidad Alianza.docx
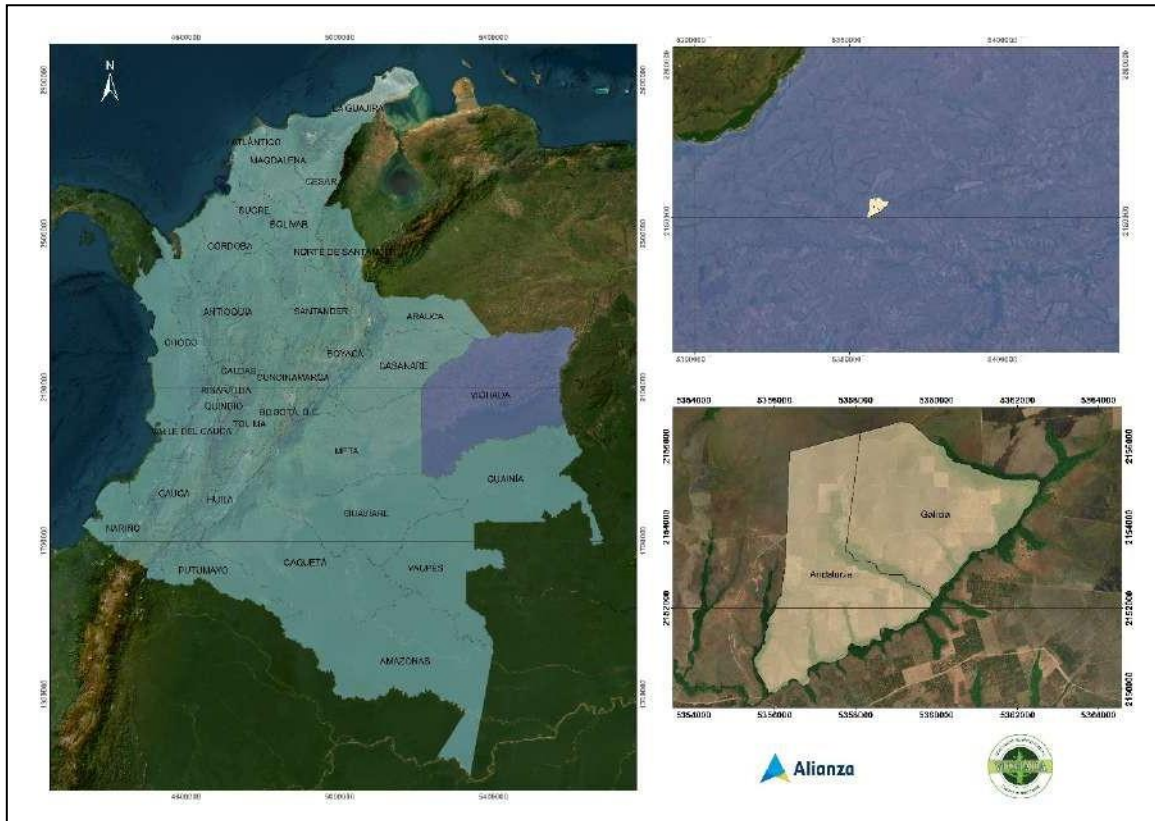
Figure 1 General location of the project Proyecto de Carbono Forestal Vichada Alianza Fiduciaria S.A.

The areas where the project is being developed correspond to two properties, Andalucía and Galicia with an area of 1,300.99 ha and 1,223.66 ha respectively (total 2,524.65 ha).

Within the properties, a multitemporal analysis was used to determine the areas that meet the requirements of the standard and are therefore eligible. This area corresponds to 826.94 ha in Galicia and 818.91 ha, for a total of 1,645.85 eligible hectares. Of this eligible area, a total of 1,641.70 hectares was planted, which corresponds to the value of the project area.
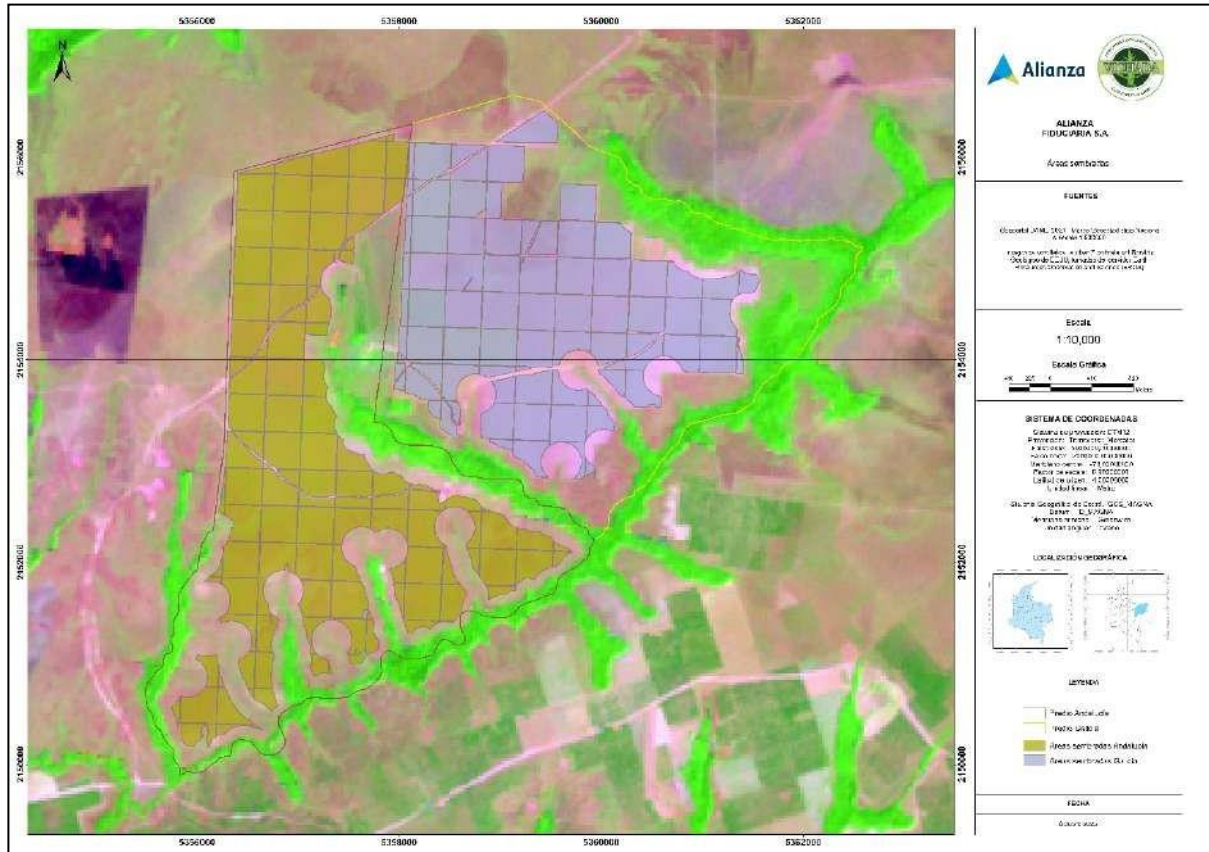
Figure 2 - Location of the properties of the Proyecto de Carbono Forestal Vichada Alianza Fiduciaria S.A., Andalucía and Galicia properties.

1.5 Summary Description of the Implementation Status of the Project

The project generates net 30,654 tCO2 GHG removals and 24,523 tCO2 as carbon credits from ARR activities in the monitoring period (01/01/2018 – 31/12/2019) that is being submitted for verification, for all sinks considered (above-ground and below-ground biomass, soil organic carbon, shrubs, leaf litter and dead wood on soil).

The production of native shrubs is predominant within the plantations, as they are left there for several years before thinning interventions or final harvests are carried out, making them one of the sinks of biomass area in the stands.

On the other hand, the project contributes to SDGs 8, 12, 13 and 15 through the development of its activities. This takes into account not only benefits to the community of the area and the biodiversity of the area, but also generates GHG removals.

In this way, the generation of income from the environmental service associated with the removal of atmospheric CO2 as a result of the creation of new forests, contributes to national goals of mitigation of global climate change in the agricultural sector, improves regional environmental conditions, recovers and improves soil conditions to be more productive areas in the future and allows project proponents to assume economic risks by improving cash flows from the sale of the carbon environmental service.

2 Title, reference and version of the baseline and monitoring methodology applied to the project.

Table 2 – Methodology and tools applied by the project

Methodology/ Tool applied	Version	Reference
BCR0001 quantification of GHG Emission Reductions GHG Removal Activities	4.0	Used in the calculation procedures, see section 3.7 of the PD and section 16 of this document.
Combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities	1.3	Used in the identification of the baseline and additionality procedure (*see sections 3.3 and 3.4 of the PD respectively*)
BCR SDSs Tool	1.0	Used in the identification of the project environmental and social aspects, see section 8 of PD
BCR SDGs tool	1.0	Used to determine the project's contribution to the sustainable development goals (see section 11 of PD and 4 of this document)
AR-Tool14 tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"	4.2	Taken into account in the quantification procedures, see section 3.7 of the PD and section 16 of this document.
AR-Tool 16 A/R Methodological tool, "tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities"	1.1.0	
AR-TOOL12 "Estimation of carbon stocks and change in carbon	3.1	

Methodology/ Tool applied	Version	Reference
stocks in dead wood and litter in A/R CDM project activities"		

3   Registry or participation under other GHG Programs/Registries

The project is not registered or seeking registration under other GHG programs.

4   Contribution to Sustainable Development Goals (SGD)

There was applied the BCR SDGs tool v1.0 to identify the project's contribution to the sustainable development goals (annex: Section 11 - SDGs), obtaining the following outcomes:

Table 3 – SDG Contributions of the Proyecto de Carbono Forestal Vichada Alianza Fiduciaria S.A.

Number of SDGs to contribute	Target related	Justification	Contributing Activities	Consolidated Media (Current Verification Period)	Annex related
SDG 8 – Decent work and economic growth	8.5 - By 2030, achieve full and productive employment and decent work for all women and men, including young people and people with disabilities, as well as equal pay for work of equal value	The project contributes to the objective in question because it hires personnel to carry out the project activities, contributing to the economic growth of the region.	Contracting	**2018-2019**, generation of 164 jobs	Section 9 - Socioeconomic aspects \Hiring
SDG 12 – Responsible consumption and production	12.2 - By 2030, achieve sustainable management and efficient use of natural resources	The development of the project as such contributes to the objective in question because it is framed in the strategies of responsible production and consumption, being a forest plantation. In addition, it should be noted that there was no project of this category in the area.	Implementation and development of the project / Training	**2018-2019**, execution of 1 project (the present) with the modality of sustainable consumption and production; realization of 18 trainings	Section 9 - Socioeconomic aspects\ Trainings
SDG 13 – Climate action	13.1 - Strengthen resilience and adaptive capacity to climate-related risks and natural disasters in all countries	The project contributes to the goal in question because its main objective is to replace greenhouse gases.	Implementation and development of the project / Removal de GEI	**2018-2019**, execution of 1 project that contributes especially to the reduction of fires; removal of 31758 tons CO2 eq.	Section 3 - Quantification of GHG emissions reduction\ Quantifications and see section 6

Number of SDGs to contribute	Target related	Justification	Contributing Activities	Consolidated Media (Current Verification Period)	Annex related
SDG 15 – Life on land	15.1 - By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and the services they provide, in particular forests, wetlands, mountains and arid areas, in line with the obligations under international agreements 15.2 - By 2020, promote sustainable management of all types of forests, end deforestation, restore degraded forests and increase afforestation and reforestation globally	The project contributes to the objective in question because it carries out the reforestation and recovery of an area where the soil was previously degraded and had extensive livestock use	Reforestation / Plantation management and control / Reforestation	**2018-2019**, 10% increase in the proportion of forest area for reforestation activities; 53.6% increase in the proportion of sustainably managed forest area; 80.67% of rehabilitated areas (in relation to the total project area)	

5 Compliance with Applicable Legislation

Law	Characteristics	Compliance
Decree 1449 of 1977. Article 3.	It lists actions aimed at the protection of water resources. For this reason, it defines measures for the areas of retreat and protection. Establishing minimum margins of protection which are ratified by corporations in subsequent decrees.	The project defines the retirement areas in accordance with the regional standards of the Corporinoquia corporation. Likewise, for the Forest Carbon component in the eligibility analyses, the areas that are within the protection and withdrawal band were considered NOT eligible, even if these areas did not historically present forest cover.
Decree 1791-1996	Any person who needs to take advantage of the natural resources of the Forests to satisfy basic needs, to market their products, to carry out scientific research or for the construction of works, must apply for the respective permit from the Corporation, in accordance with the required requirements.	Chapter XI of this decree determines that, for commercial plantations, it is sufficient to develop the registration with the Colombian Institute of Agriculture (see records on annexes Section 2 - General description of the project\Project activities\Forest Records) and the Forest Establishment and Management Plan, presented by the beneficiary of the Forest Incentive Certificate (CIF, see annexes Section 2 - General description of the project\Project activities\Forest Records) will serve for the Corporations to carry out the registration of the plantation. Resolution 0687 of 1997 is incorporated into this decree, which determines the actions by which the forest resource administration regime of the Orinoquia-Corporinoquia Regional Autonomous Corporation is issued.
RESOLUTION NO. 0687 of 22 December 1997	Whereby the forest resource administration regime of the regional autonomous corporation of the Orinoquia - Corporinoquia is issued.	The project complies with Chapter VIII related to the conditions of commercial forest plantations, and has submitted the required documents (e.g., establishment and management plan) for the start of activities adjusted to regional standards.
DECREE NO. 4296 OF 2004	Regulations for controlled open burns in rural areas.	The project complies with national and regional regulations, and does not include in its management practices the residue of waste in soil preparation activities, or the burning of waste derived from maintenance.

Law	Characteristics	Compliance
Resolution 200.41-11-1130 of June 22, 2011. Update 0687 of December 22, 1997. And Resolution 50041131571 of November 6, 2013.	Whereby the forest resource administration regime of the regional autonomous corporation of the Orinoquia - Corporinoquia is issued. In order to guide regional productive development, Corporinoquia adopts a tool that requires environmental management and technical procedures to develop in a sustainable way the activities that are immersed within agricultural, forestry and agro-industrial productive projects.	The *Proyecto de Carbono Forestal Vichada Alianza Fiduciaria S.A.* has implemented the recommendations of the resolution and its updates by protecting water sources and remaining forests. The project has a registration and monitoring file in the Corporation where compliance monitoring is detailed. Environmental management policies are adopted and presented to the corporation on a regular basis, and their monitoring and follow-up are recorded and included in the project file that rests with the corporation.
Decree 3930 of 2010.	By means of which Title I of Law 9 of 1979 is partially regulated, as well as Chapter 11 of Title VI-Part 11I- Book 11 of Decree-Law 2811 of 1974 regarding the uses of water and liquid waste, and other provisions are issued	The project has the respective applications and approvals for the management of water resources and the potential polluting discharges that are generated. It complies with the due withdrawals for the protection of water sources dictated by article 40 of said decree (see previous paragraphs). The documents related to this decree are contained in file number 800.44.2.12.004 of the Corporation related to the forestry project.
Ley 1377 of 2010. Articulo 7	The purpose of this Act is to define and regulate forest plantations and agroforestry systems for commercial purposes.	The project conforms to the definition of *Forestry Activity for Commercial Purposes*, specifically complies with Article 4 on the registration of plantations larger than 10 hectares before the Ministry of Agriculture and Rural Development or whoever takes its place, in this case the ICA and has the due registration of all the lots planted in the project (See Annex Section 2 - General description of the project\Project activities\Forest Records) and Article 7, related to the *NON-establishment* of commercial forestry activities, protected forest areas, special management areas or any other category of management, conservation or protection that excludes such activity, as well as strategic ecosystems, such as moorlands, mangroves, wetlands. As a principle

Law	Characteristics	Compliance
		of eligibility, no area will be established where at least 10 before presented forest cover, also for the registration it was evidenced that the areas to intervene are not within the lagoon figure of conservation or protection of ecosystems.
LAW 139 OF 1994.	Whereby the Forest Incentive Certificate is created and other provisions are issued.	The project complies with the conditions established by said law, complies with the requirements and submits the documentation to access the CIF, having positive approval.
Document National Council for Economic and Social Policy (Conpes) 3827 of 2015.	Distribution of resources for the certificate of forest incentive for commercial purposes (CIF of reforestation) - valid 2015.	The project proposal complying with Conpes 3827, demonstrates the suitability of the territory for the distribution of resources Effective 2012, for projects that begin this year, with prior approval of the suitability of compliance. In addition, the selected species are within those required in Part III, related to suitable forest species Forest species that have technical support that demonstrate export potential, among others such as: Acacia (*Acacia mangium*), Melina (*Gmelina arborea*), *Pinus* (*patula*, *caribea*, *tecunumanii*, *oocarpa*, *maximinoii*), *Eucalyptus* (*grandis, pellita, tereticornis*) and Teca (*Tectona grandis*), Caucho (*Hevea brasiliensis*) and Guadua (*Guadua angustifolia*).
Decree 2448 of 2012.	Partial modification of decree 1824 of 1994. Definition of: forest species, native forest species, introduced forest species, protective-producing forest plantation, forest establishment and management plan, eligibility, granting, payment, new plantation and forestry project.	The project is accepted at the time of approval and granting of the disbursements established by said decree, being consistent with Conpes Document 3724 that allocated the resources under the procedures described and defined prior to Decree 2448 of 2012.
Resolution 1447 of 2018.	Which regulates the system of monitoring, reporting and verification of mitigation actions at the national level	This resolution establishes the deadlines for the registration of initiatives with RENARE. In September 2019, the project initiative submitted formal registration to the Ministry of Environment and Sustainable Development (see annex

Law	Characteristics	Compliance
	referred to in Article 175 of Law 1753 of 2015, and other provisions are issued.	Section 4 – Legislation/C.3. RENARE). In response, it was argued that the RENARE platform should not be launched, so registration should be done at the time of its operation. All processes will be fulfilled as soon as it is fully operational. See letter submitted for registration (see annex Section 4 – Legislation/C.3. RENARE). Currently, after the platform is fully functional, the project is registered in the Feasibility Phase (see RENARE platform[2]) In addition, it establishes the development of the Baseline analysis for emission removal projects (art. 35). This baseline analysis can be verified in section 6.2 hereof.

6   Climate change adaptation

In accordance with (Andrade, y otros, 2013) cited by (Cisneros Ramirez & Amezquita Picon, 2015) forest plantations have a diversity of approaches that allow them to improve their adaptation capacity, as the process of genetic material and silvicultural treatments compared with natural forests can be adjusted more easily.

In that same sense, (Chaparron Pinzón , y otros, 2007) highlights that forest plantation projects, in addition to the other categories of CDM forestry projects, generate positive impacts on biodiversity and ecosystems, in addition to contributing to the conservation of water resources and the improvement of soils.

Proyecto de Carbono Forestal Vichada Alianza Fiduciaria S.A. consists of a forest plantation through which GHG reductions are generated and that also has the characteristics of a commercial plantation CDM project, it is possible to carry out the following analysis in accordance with the established in section 10.8 of the BCR Standard v3.2:

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[2] http://renare.siac.gov.co/GPY-web/#/gpy/datbasreg/13/1721

- The project is in line with the with the National Climate Change Policy, whose objective is to promote climate change management that contributes to advancing a path of climate-resilient and low-carbon development (IDEAM, 2018), this being a project framed in strategies for the reduction of GHG emissions.

- The project improves conditions for the conservation of biodiversity and its ecosystem services, and its activities generate sustainable and low-carbon productive landscapes, taking into account that it is a commercial plantation developed in a non-forest area.

- The project integrated actions that assist in the efficient use of soil, including, land use consistent with land vocation and agroecological conditions that increases competitiveness by reducing vulnerability to climate change, as the project activities description evidence (see section 2.3 of the PD).

- The project proposes areas with restoration processes in areas of special environmental importance, taking into account that part of the areas of the properties where the project is developed correspond to protection areas because they are riparian forests (see annex Section 1 - Project type and elegibility\Elegibility).

- The project develops forest production systems more adapted to high temperatures, droughts or floods, to improve competitiveness, income and food security, especially in vulnerable areas, taking into account that it is developed in an area where the main activity is extensive livestock farming, which favors the risk of drought and soil degradation due to erosion.

- The project develops comprehensive actions that help the efficient use of land, since the conservation of the natural riparian forest covers existing on the properties where the project is developed is contemplated.

- The project generates a reduction in GHG emissions from agricultural activities, compared to the scenario without the project, taking into account that the baseline scenario corresponds to extensive livestock farming.

- The project develops actions directly related to adaptation measures to climate change, taking into account that a forest plantation is established on two

properties that have riparian forests associated with bodies of water, so the development of the project contributes to their conservation.

7   Carbon ownership and rights

The Andalucía and Galicia properties are registered under public instruments of the municipality of Puerto Carreño (Vichada) with the following real estate registration numbers (see annex Section 5 - Carbon ownership and rights\Ownership).

Table 4 – Real State Registration of the two properties where the Project is located

Property	Real estate registration
Galicia	540-1856 (Previous La Pringosa Property)
Andalucía	540-1925 (Previous Tatacoa Property)

As established in these documents, governance and the area under control are in coordination with ALIANZA FIDUCIARIA S.A. The legal ownership documents are confidential in nature and are presented in Annex Section 5 - Carbon ownership and rights\Ownership. (Ownership to the auditing and certifying entities of the project).

The due demonstration of land tenure (see annex Section 5 - Carbon ownership and rights\Ownership), the proposal to develop commercial forestry activities on the project properties and include the benefits from the sale of the environmental service of carbon capture by the new forests (see Anexos\B. Registros Forestales\CIF\Contratos CIF).

8   Environmental Aspects

In this way, an Environmental Management Plan has been presented to the Corporinoquia corporation, which includes aspects related to monitoring and tracking (Annex Section 8 - Environmental Aspects) of the biotic components. This allows for an evaluation of its status in the baseline and how the project activities can generate positive or negative impacts on this environment and specifically on the pre-existing forested areas.

The environmental management plans and measures have not yet been approved, so the actions are carried out in compliance with the regulations and their evaluation by the corporation is awaited.
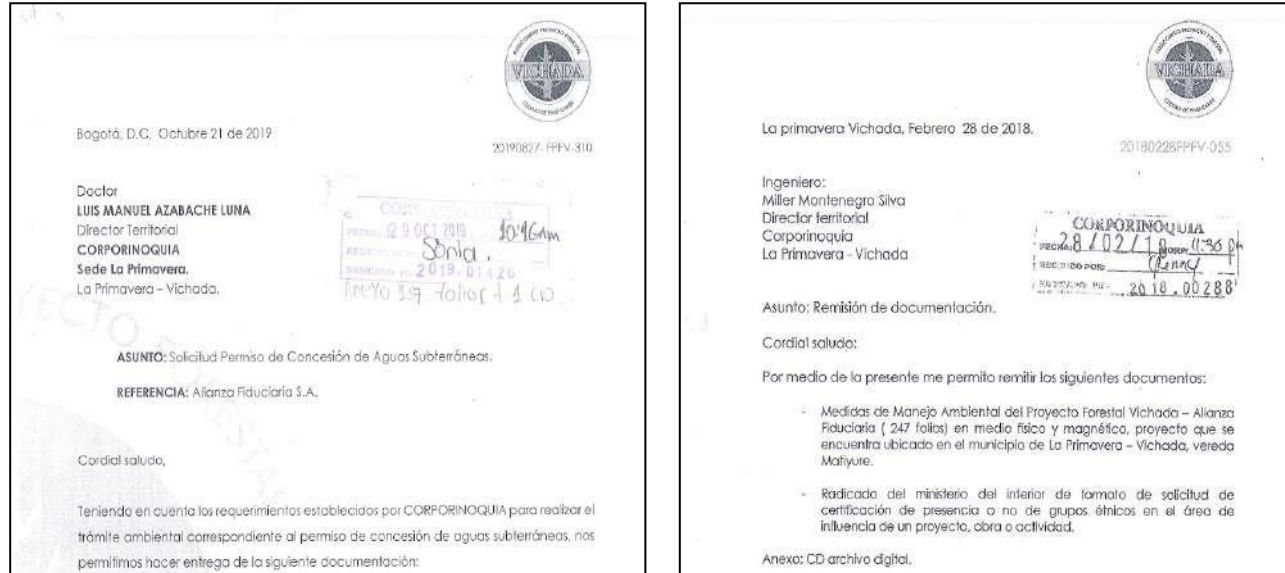
Figure 3 - Image of the letters requesting approval of Environmental Management measures.

Regarding the biotic component, it is intended to track and monitor it, which will only be implemented when the corporation approves the documents delivered for the environmental management measures, abiding by its recommendations for the monitoring of this component. For more information on biotic characteristic, please refer to Section 8 of the PD.

On the other hand, it is important to clarify that the BCR SDSs Tool was used in the identification of the project environmental and social aspects, to see its development and compliance, please refer to section 8 of PD.

9   Socioeconomic Aspects

The project does not cause any net harm to the local communities, on the contrary, among the social benefits that are expected to occur for the project developed are the generation of direct and indirect employment, modernization of the workforce, development of productive and social infrastructure that can be used for other projects, local demonstration of how reforestation activities contribute economically to development. sustainability of the region, generation of productive alternatives and sources of employment (one hectare of reforestation uses more labor than extensive cattle ranching). The future wood transformation chain associated with the project's forestry production cycle will require training and qualification of personnel, promoting new work skills in the community.

In addition, the project activities have promoted employment in the region, there is no consolidated information on these activities, but it is estimated that one job is generated

for every 10 hectares. In this way, for the 1,641.70 hectares established by the Project, a little more than 164 jobs have been generated in forestry activities.

10 Stakeholders' Consultation

No specific consultations have been developed taking into account that the owners are fully aware and have control of all the families that inhabit the project area, since they are project workers who are allowed to live in while they are part of the work activities of the project. project. These families are notified of the project activity. Additionally, it is important to mention that the residents of the project area are notified of the project initiative and do not present any objection, however, the telephone number and contact email were shared with them in case they wanted to present any complaint, suggestion, or claim. Annex: Section 10 -Consultation with stakeholders

11 REDD+ Safeguards

Not applicable, since this is not a REDD+ project.

12 Special categories, related to co-benefits

Not applicable.

13 Grouped Projects

Not applicable since this is not a grouped project.

14 Implementation of the project

14.1 Implementation status of the project

- During the current monitoring period (01/01/2018 – 31/12/2019), there were developed activities of remote sensing and field inventory described in section 16.2.3.

- On the other hand, the leakage was analyzed under literal a) of section 15.3 BCR0001 and therefore considered as **zero** (see section 16.3).

- Regarding uncertainty management, in the quantification of baseline and mitigation results, Table 3 "*Discounts for quality and applicability of GHG estimation models*" of the BCR0001 methodological tool was taken into account in the project calculations, where it is indicated the quality discount factors

associated with GHG removal data, applying a discount value of 20%, for national aboveground biomass data and (R:S) factor for belowground biomass.

14.2 Revision of monitoring plan

The monitoring plan was reviewed through the internal quality assurance and control system (described in section 15.1.5.4).

14.3 Request for deviation applied to this monitoring period

Not applicable since there is not methodology deviations.

14.4 Notification or request of approval of changes

Not applicable since the project is under validation and forts verification process.

15 Monitoring system

15.1 Description of the monitoring plan

To implement the Proyecto de Carbono Forestal Vichada Alianza Fiduciaria S.A., the following methodology has established a series of procedures to guarantee clear accounting of the greenhouse gases that would be mitigated, in this case the CO2 captured and fixed forest covers that are growing. Therefore, the implementation of monitoring after the project is approved and established is based on:

15.1.1 Monitoring of physical limits of the project.

These include the areas that are part of the project. They must include those that have been planted and will be planted, and that are under control. Likewise, many areas may not be planted due to soil conditions, flooding, among others, and it is intended that they be included in the accounting for passive natural regeneration. Another aspect is to control areas where anomalies occur that affect the accumulation and conservation of captured CO2, such as fires, pests, etc. Finally, it must be taken into account that the control areas are those actually planted, that is, areas that do not have forest cover such as firebreak corridors or roads, should not be considered in the accounting, even if they are part of the project, in addition to those areas that are planted and that are outside the eligibility analysis developed in the ex ante phase.

15.1.2 Monitoring of the forest establishment.

Here we want to guarantee the quality of the stands that are planted, realizing that they comply with the procedures detailed in the proposed project. This monitoring must be

carried out at least during the first three years after establishing each lot and with longer periods, especially when pruning, thinning and final harvesting activities are carried out for each lot.

The components to consider are:

Species actually planted: in many cases, despite the species having the appropriate technological packages, their development for the project region is not as expected, leading to high mortality and poor development of the stands, affecting the projections of CO_2 capture, for which the change of species is necessary to give continuity to the commercial forestry project.

Monitoring mortality and replanting. It is important in the first year of establishment to maintain homogeneity of the stands at optimal densities per hectare. This monitoring allows for replanting in a timely manner, since late replanting within the same plot, in many cases, generates asynchrony in the development of the trees and would require different management plans in those spaces with replanting.

15.1.3 Forest management monitoring.

These activities undoubtedly also affect the greenhouse gas balances that are to be mitigated, given that poor stand development affects their growth and atmospheric carbon capture. The aspects to be monitored are associated with activities carried out by species, lot, intervened area, and farm. These are: Cleaning of plots after sowing (biomass removed and left within the plots), pruning (intensity, biomass or volume removed), thinning, or harvesting (intensity, biomass or volume removed), replanting of stands that are of several rotations over the duration of the project, monitor disturbances such as burning, diseases and biomass loss as a result of said condition. Finally, the development of the trees is evaluated through growth monitoring plots. To monitor the development of the project, the stratification of the stands is necessary.

Stand stratification: Stratification is key when performing reduced emissions assessments. It is recommended to develop stratifications based on aspects such as: species, sowing date, silvicultural management, among others, since it is presumed that these aspects will allow unifying lots that present similar removal conditions and carbon content. However, it is highlighted that stratification seeks to unify areas with similar carbon content, regardless of management or species, since these can have effects such as pests, fires, site qualities, among others that make stratification reformulate.

For the current project proposal, stratification will be developed, initially discriminating into two types of stands:

- **Commercial stand model:** composed of species of commercial interest that will be subjected to silvicultural management.

In turn, these two stand models will have stratifications based on their development and accumulation of biomass - carbon, which will be initially evaluated with satellite image processes, using indicators such as the Normalized Difference Vegetation Index, which allows estimating the quantity, quality and development of vegetation based on the measurement of the intensity of radiation of certain bands of the electromagnetic spectrum from certain satellite images.

For this stratification, four levels are proposed in each type of stand:

-     Low
-     Regular
-     Half
-     High.

Below is the list of the most important variables to monitor and that will be applied in the forestry project, in the three aspects indicated above.

Table 5 - Variables for monitoring project areas

Variable	Observation
Stratum ID	Stratum, considering those initially established and the changes that may occur with the progress of the project.
Coordinates of polygons or parcels.	To control planted areas. They should be in longitude and latitude.
A_{it}	Polygons of planted areas, at time t, and within a definite stratum j.
A_T	Total area that corresponds to the sum of all the lots that are part of the project.
Adist	Areas altered by natural or human disturbances (harvesting, thinning).

Table 6 - Variables for monitoring the forest establishment.

Variable	Observation
Localization	Geographical position where each activity takes place.
Aikt	Area intervened by activity
Site Preparation	Preparation of sites at the beginning of the project in ha.

Variable	Observation
Biomass removed prior to establishment.	Only tree biomass is considered for site preparation emissions.
Species	Species that are actually planted by stratum.
Survival check I, j, k.	Survival after planting.
Plantation	Date of planting of the lots.

Table 7 - Variables for monitoring forest management

Variable	Observation
Prepared area$_{i,j,t}$	Area cleaned prior to establishment. These areas generally correspond to the same areas that are planted.
Biomass removed in soil preparation.	Biomass removed during cleaning.
Planted area $_{(i),j,t}$	Areas under control that are effectively planted
Fertilized area	Fertilized area, in order to establish good management procedures, but it is not considered as emissions.
Areas Cleaned	Area that is subjected to cleaning where the stands are established.
Pruned area	Area where stands are pruned.
Thinning area	Halfway area
Biomass removed by thinning or its percentage	It can affect the carbon contents of stands and needs to be monitored.
Harvested area	Areas that complete their rotation cycle.
Harvested Volume	Reported harvest volumes by species.
Reestablished Areas	Amount of area replanted and year, to start a new rotation.
Riot area	Area affected by disturbances such as fires, plagues, mortality, etc. The survey is done with GPS.

Other elements to monitor are aspects related to the social and biodiversity component.

Basically, these elements are based on:

-Social: impact on the generation of jobs in the project area and its compliance with national hiring standards, and training for the qualification of personnel. Likewise, do not affect territories with the presence of ethnic communities.

For this component, monitoring the employment indicators per year becomes the most important, since, as noted in previous paragraphs, the non-presence of ethnic communities in the project areas was demonstrated.

-Biodiversity: This monitoring is articulated to the demands developed by the regional autonomous corporation, which within its policies establishes monitoring and control of the impacts that the project activity may generate to the biotic component, especially biodiversity and specifically to the vulnerable species, or Conservation Target Values (VOC). Under this component, the list of species present in the region and their conservation status will be updated based on updated regional studies and complemented by monitoring carried out by the project. For the project and following the environmental requirements of the Corporinoquia environmental corporation, through file number 800.44.2.12.004 of the corporation, periodic monitoring is carried out of compliance with the biodiversity component in the areas of influence of the project.

Finally, it is planned to develop processes related to the Quality of information. This provides for the optimization of control and quality of the information collected. The process focuses on a control plan in the collection of information, archiving, verification and internal audit of the resulting information, guaranteeing the integrity of the accumulated data for each monitoring period and throughout the execution of the proposed project activity.

15.1.4 *Proposal for the implementation of the monitoring plan for changes in carbon content in established stands*

- Verification of species and strata: The stands involved in the project are verified against the species and strata predefined in the project and will be stored in the database, according to the stand model to which they belong.

- Survival: This is quantified in the field through sampling in temporary circular survival plots, with an area of 200 m^2 (Figure 4). Survival monitoring is carried out approximately three months after the plots are planted. It is established that, if a survival of less than 90% of the initial amount planted is detected, the missing material must be replanted with the same species, seeking to keep the plots homogeneous in age and development. The estimate is made through a simple count of the individuals within each plot, verifying their state of vitality; Then the density of living individuals is determined and finally compared with the initial establishment density.
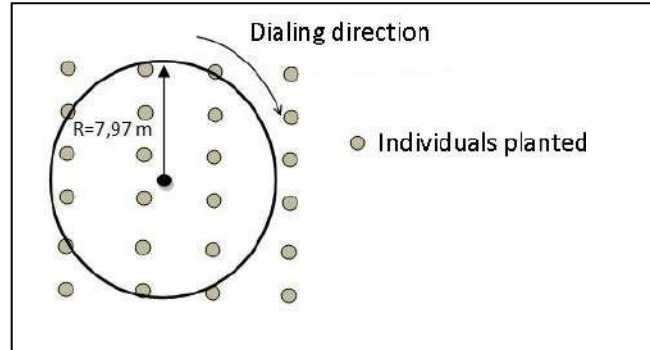
Figure 4 - Scheme of the temporary survival monitoring plot.

15.1.5 *Monitoring of net removals by sinks and data acquisition*

The monitoring of this component is carried out through temporary or permanent plots, in which the dynamic growth process of the plantation is evaluated, in order to estimate the carbon content present in the above-ground and underground tree biomass of the project. The inventory of the plots allows evaluating the correspondence of the species planted with those proposed in the project, in addition to the planting densities.

The protocol for establishing plots and measuring dendrometric variables will be followed to estimate the volumetric increases in each stand. This information will serve as input to validate the volumetric equations by species, or to reformulate new equations that allow the volume to be modeled more realistically. achieved by the species planted for the project area.

Below are some of the most important parameters to monitor:

15.1.5.1 Stratification.

The defined strata will be monitored in a database where species, area, lot, planting date, etc. appear. which will be stored in physical and digital format. Said database will be additionally supported with the respective cartography. The updating of areas that are incorporated into the project is suggested to be done quarterly, allowing permanent control and monitoring of the areas by stratum.

15.1.5.2 Monitoring of the strata.

The areas of the previously defined strata will be periodically monitored according to the criteria established in the monitoring of the scope of the project (previous paragraphs), seeking to identify parameters of changes in the initially established areas, and promoting the unification of strata considered as dissimilar in the phase. ex ante. According to the changes in carbon accumulation in each monitoring period, a new stratification may be proposed that groups stand with similar accumulations and other

aspects in common. If a pre-sampling is developed before the first monitoring, then the results of this will allow a re-stratification, based on changes such as:

- Age
- Forestry management
- Possible variation in carbon capture
- Cost effectiveness in the monitoring process
- Disturbances (pests, fires, pathologies, etc.)

Some changes in the parameters defined above are only detected after the development of the first monitoring, such as carbon capture.

15.1.5.3   Monitoring changes in carbon contents.
15.1.5.3.1 Mapping

Maps of different scales may be used, however, large scale maps such as 1:10,000 are recommended to facilitate the distinction between models and lots. It is advisable to have a series of maps of this type by strata and the generation of a single map for field monitoring will be avoided. In this way, the groups in charge of the inventory will have facilities to make tours and locate distinguishable sites in the field to access in subsequent monitoring or to facilitate access for the monitoring intervention group. This cartography will document altimetric references, geographical features (such as drainage), road infrastructure (here primary and secondary roads are included, characterizing their type, that is, paved or not), possible division of the lots, characterizing the location of the stand with dissimilar colors from each other. There will be a general map of the lots and models that summarize the maps generated for field monitoring. This can be of a higher scale (1:50,000, 1:100,000) and will serve as support for monitoring planning. For each monitoring period, the project map base will be updated, and data on areas planted and under control for said period will be included. As support for cartography, aerial photographs may be used for plot location procedures.

15.1.5.3.2 Sample size.

A series of sampling plots will be established to identify the changes and evolution of carbon accumulation in the stands. These plots will be established using cost-effectiveness criteria, maintaining a level of precision of □ 10% of the mean, with a confidence level of 95%.

The procedure to calculate the sample size follows method I of the methodological tool for calculating sample size[3]:

Steps:

- Identify the parameters according to the project proposal, to estimate the amount of sample needed.

Parameters:

  A: Total project area; ha
  I: Stratum
  Ai: Area of each stratum i; ha
  AP: Monitoring plot area; ha
  sti: standard deviation of the estimate by stratum i

- Calculate all plots of the defined size for the entire project area

$$N = \frac{A}{AP}; \qquad N_i = \frac{A_i}{AP},$$

where:

  N: maximum number of possible plots in the project area
  Ni: maximum number of possible plots in the area of stratum i.

-Estimate the allowable error, based on the desired precision levels and by estimating the average volume (or biomass)

$$E_1 = Q_1 * p$$

Where:

  Q1: Estimated average value for the amount of volume or biomass in the project.
  Q, t ha^{-1}, m^3 ha^{-1}.
  P: Precision level (e.g. 10%)

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[3] Calculation of the number of sample plots for measurements within A/R CDM Project activities. ver 02.

E1: Allowable error (10% of the average)

- Estimate the number of plots for the entire project assuming equal costs of establishing the plots, using the following equation:

$$n = \frac{\left(\sum\limits_{i=1}^{m_{PS}} N_i \cdot st_i \right)^2}{\left(N \cdot \dfrac{E}{z_{\alpha/2}} \right) + \left(\sum\limits_{i=1}^{m_{ps}} N_i \cdot (st_i)^2 \right)}$$

Where:

n: total number of plots in all strata of the project
$z_{\alpha/2}$: value of the z statistic, for α = 0.05 (indicated for a 95% confidence level), $z_{\alpha/2}$ = 1.9599

- Estimate the number of plots per stratum assuming equal establishment costs:

$$n_i = \frac{\sum\limits_{i=1}^{m_{PS}} N_i \cdot st_i}{\left(N \cdot \dfrac{E}{z_{\alpha/2}} \right)^2 + \left(\sum\limits_{i=1}^{m_{PS}} N_i \cdot (st_i)^2 \right)} \cdot N_i \cdot st_i$$

where:

st_i: standard deviation of the estimate for stratum i
i: 1, 2, 3, … L strata of the project
n_i: number of plots in stratum i.

The number of plots per stratum for the project can be determined using the tool generated by Winrock International[4].

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[4] Winrock Terrestrial Sampling Calculator.
ww.winrock.org/ecosystems/files/Winrock_Sampling_Calculator.xls

15.1.5.3.3 Type of plots

The shape of the monitoring plots is rectangular with a size of 500 m² of area (20 x 25 m) in all systems (Figure 5). If situations arise in which a plot of these dimensions cannot be established, the shape of the plot will be adjusted ensuring that the area of 500 m² is maintained.
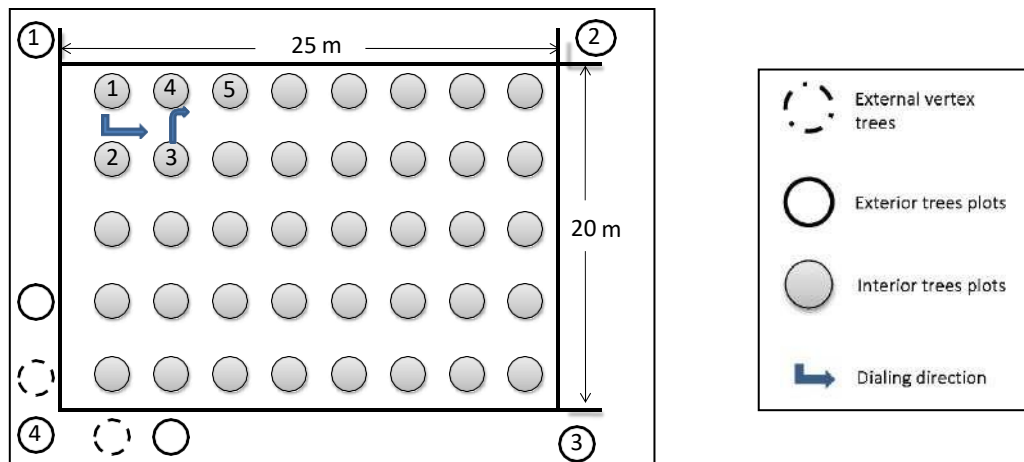
Figure 5 - Survey of monitoring plots. The dimensions correspond to 25m x 20m, for an area of 500m²

15.1.5.3.4 Location and survey of the plots

After having carried out the distribution of the plots systematically on a map of the established coverage, with the geographical points the center point of the plot is in the field with GPS. The entry route to the plot must be marked to facilitate its subsequent location in other monitoring or in the audit process. This point will be called vertex one and in a clockwise direction the initial lateral corridor of 25m is established, until vertex 2 is located and so on (see Figure 5). Then the three exterior trees that determine each of the vertices are marked (with the respective vertex number). In this way the plot is delimited. Then we proceed to mark each of the trees with successive numbering. You should try to have permanent markings, with plates that do not damage the tree and paint. Finally, information is placed on tree 1 with paint detailing the plot code and planting date. These procedures are shown in more detail in the protocols designed for this purpose.

15.1.5.3.5 Measurement and estimation of carbon content over time

Estimates of removals will be made using the equations available in the scientific literature for environmental conditions similar to those of the project, equations proposed by the IPCC good practice guides for stand models and their species, and some of the recommendations from the tool "*Demonstrating appropriateness of allometric Equations for estimation of aboveground tree biomass in A/R CDM project activities*" to define

equations to apply ex-post. Finally, if possible, equations will be built with primary information about the project.

Therefore, from the monitoring plots the dendrometry variables are breast height diameter (dbh, at 1.3 m above ground level) and total height (h).

The expansion factors of the aboveground biomass are those suggested by the Good Practices Guide, in addition to the root – stem relationships for estimating underground biomass. However, new values reported by the literature or estimated under conditions and species similar to those of the project may be used, giving priority to national information.

From the information collected in the first monitoring period, new volume equations can be adjusted, and appropriate estimates made for the proposed project and the species considered.

The detailed procedures for this purpose are detailed in the field sampling plan protocol (Annex Section 17 - Monitoring plan).

15.1.5.3.6 Quality assurance and control in monitoring procedures.

The procedures established by the project will be followed, which guarantee the quality of the information collected and its proper filing.

The procedures initially consist of training the personnel in charge of taking, collecting, and filing information. As a second instance, the real capacity of the personnel in charge of making analyzes and estimates will be evaluated, based on the monitoring information carried out. Likewise, there will be forestry technicians who will support the execution activities of establishing the stands, so that they are in accordance with the approaches described and the objectives set by the project.

A management structure is established that allows viewing a scale of command and those responsible to guarantee control over the quality of the information.

For the training of personnel, there will be a series of protocols, formats and forms that allow standardizing the processes of establishing monitoring plots, collecting information in the field (dendrometry variables), incorporating the collected information, analysis, etc. Therefore. According to the methodology, four fundamental stages are considered to ensure transparent and accurate estimates of GHG removals provided by the project:

- Reliability in field measurements.

The protocols designed for the training of personnel in charge of establishing plots and in charge of measuring dendrometry variables (height, diameters, circumference at chest

height), guarantee the standardization of procedures. The training of said personnel will be in charge of a forestry engineer and supported by technicians, who will be in charge of directing the monitoring teams.

The need to make adjustments to said protocols will be periodically evaluated, without generating alterations in the values of measurements made previously. This in order to adjust the protocol each time to the condition of the region, planting dynamics and incorporation of areas under control that will enter the project.

The training time will be as long as necessary to guarantee sufficient knowledge in the handling of measuring equipment and instruments. Therefore, training must have theoretical and practical measurement procedures and avoid errors in measurement and typing of information.

Procedure for identifying measurement errors.

This audit procedure consists of carrying out a subsequent verification of the data obtained from the forest inventory or monitoring and will have the following characteristics and steps:

- It will be carried out by personnel different from those who carried out the inventory and who will be characterized by having extensive experience in forest inventory procedures and estimates of wood volumes for various species. Of special consideration, the person in charge of this measurement must be unaware of the results of the measurements to be audited.

- Between 10 and 20% of the total plots established in the forest inventory must be taken.

- The instruments used must present similar characteristics to those used in the initial inventory.

- The measurement procedures will be adjusted according to the established manual steps or measurement protocols with which the staff was trained.

- Location of the plots

- Plot survey

- Measurement of diameters at chest height (dbh) and total heights.

- Compare the information obtained with the original information taken by the forest inventory crews.

- Identification of errors. This is done by comparing both information (original inventory and audit) in a paired manner.

- If errors are identified, they are corrected and recorded, expressed as a percentage of all plots that were remeasured, to provide an estimate of measurement error. The estimation error is given by:

$$Measurement\ error(\%) = \frac{Data1 - Data2}{Dato2} * 100\%$$

The allowable error should not exceed 5%.

- Verification of input data and analysis.

The information entry phase, to bring the information into digital spreadsheets, will be carried out by qualified personnel for this task and its analysis will be carried out by personnel trained in estimating carbon content in biomass.

To detect errors in the entry of data into the digital spreadsheets, a person other than the one initially in charge of entering the data will enter between 10 and 20% of the field forms into an additional spreadsheet. The results of the two calculations (original and audit) are compared to detect errors. Any errors noted will be corrected in the original file. Estimation of typing error:

$$Measurement\ error(\%) = \frac{Number\ of\ errors\ identified}{Total\ number\ of\ the\ checked\ sample} * 100\%$$

When errors are identified due to adjustments to integer values in decimal measurements, these should be adjusted to the lowest order integer to guarantee conservative evaluations of the measurements.

15.1.5.4   Information Control and Quality Assurance

This procedure is developed through the application of the following 7 steps:

Figure 6 - Protocol for taking and storing information.

1. Identification of the need: At this point, the best way to collect information is

    established to solve a need that can be of various types and respond to different

areas of the organization, such as accounting, GIS, SST, Environmental, Commercial, Legal:

- physical or field; photos, GPS surveys, sampling, preparation of studies, among others, plot surveys.
- external information: such as certifications, records of work performed, satellite images, contractor documents, purchasing supports.
- internal information; balance sheets, reports, analysis, studies, among others.

2. Gathering information: Once it is established how the need is satisfied, we proceed to identify the necessary resources:

   - Economical
   - Equipment
   - Ideal human resource
   - Logistic
   - Delivery medium

3. Review of information in the office: All information is centralized in the company's facilities in Bogotá after it has been obtained, this is because these facilities are where the resources for its review and storage are available.

   - All information related to the operation of the projects is admitted by the corresponding agency for analysis and review.
   - This review is carried out by personnel specialized in its management, applying concepts appropriate to the nature of the information.
   - It is carried out in order to determine that it responds to the identified needs.

4. Information organization: The information is organized differentiated by project prepared in each department, creating subfolders by theme on the computers available in the Bogotá office for each department. This is by relating the created versions in the file names and eliminating previous ones that are not valid. Once the information is organized, it is archived in two components, physical and digital.

5. Physical file: The physical file is located in the organization's Bogotá office, where each document is related by topic and project with a faithful copy of the input or document prepared, respecting the validity of the document in filing order.

6. Digital file: To complement the integrity of the physical file, since some data is of digital origin, in each department there is complete custody of the information

differentiated by project and with thematic sub-classification. This is the most complete file that serves as support and information consultation.

7. Back up: Information backup is done in two ways.

    -   Copy to external disk: Every month a backup is made to a large-capacity external disk, which is kept in a location outside the office facilities in Bogotá, whose custody is directly in charge of the establishment's Management.

    -   Cloud copy: On cloud servers, project data is temporarily backed up during execution. Once the processes are completed, they are backed up in the office and on external magnetic media and are deleted from the server.

With this process, the project built a database of information extracted from the Technical, Legal and Carbon components, which was separated into folders to associate it with the monitoring indicators of the current project. This information has been separated by folders, with the latest versions. However, complementary information rests in the digital files of the companies that are part of the project and is duly protected and supported to prevent its loss. The folders and attachments are located in the cloud, shared in GOOGLE DRIVE files, for access when required by the audit. The use of this archiving tool allows you to give differentiated permissions to whoever accesses the information, it also generates reports of the modified files, aggregates giving a report of who made the change, and safeguards a temporary file until the administrator approves the changes or deleting files or folders.

In this folder system, there are scanned legal documents, technical work information and field forms completed and duly scanned in digital formats. Likewise, it was available:

-   Spatial analysis to verify the areas of the project that are planted and receive maintenance or interventions such as pruning, thinning, among others. With date and updated versions. The CDM unit of the La Primavera Forest Project is responsible for the analysis and custody of the base information. Which feeds the databases related to Productive Forestry Technical aspects, Carbon Technical aspects and the necessary support to guarantee Financing agreements such as the CIF.

-   Analysis of carbon estimates and balances: include statistical analyzes by stratum.

-   The database delivered for the project will be the same ones that will be continually updated and fed under the BCR.

15.1.5.4.1 Definition of adjustments in DAP measurement.

During the cold evaluation that was carried out on the forest inventory, only the change in the measurement tool of diameters at breast height was identified. Originally, the use of diameter tapes was recommended, however, due to logistical problems, the measurements had to be carried out with normal measuring tapes, which have a precision of 1 mm and are made of nylon material. To down-adjust this measurement due to NOT using the recommended tool, DAP values were adjusted to integer values below the original measurement in circumference value (e.g. if the circumference value was between 15.1 to 15.9, the value was left at 15.0, always the integer value downwards).

No additional measurement errors or misuse of equipment were identified during this monitoring period.

15.1.5.4.2 Analysis of the entered information.

All data were verified and corrected before analyzing the information. Among errors identified, although infrequently, was the indifferent use of the comma as a decimal separator, when it should be a period in the database. This was corrected.

Statistical analysis.

No outliers were identified by stratum and the significant difference between them was assessed through the use of statistical packages (see annex Section 3 - Quantification of GHG emissions reduction\Quantifications\Ex post\ Ex-post 2018 – 2019.xlsx). The due uncertainty analysis associated with the analyzes was applied and the discounts recommended by the methodological tool were made.

The Units in charge of safeguarding the information were divided into three:

1- Technical field unit and *silvopastoral* activities:They are in charge of monitoring forestry work, implementing forest inventories and monitoring biodiversity according to the corporation's standards, thereby documenting the actions and providing support for them.

This unit and its team safeguard information in physical and digital format, which is shared with the central unit in Bogotá.

2- Legal unit:

In charge of contracts and legal aspects related to the project. This unit will focus on agreements or contracts for reduced emissions transactions. Links the information to the transactional records following the proper registry protocols and will deliver the

information to the RENARE platform due the national laws (most updated Res 1447/2018).

3- Carbon technical unit:

It is in charge of carrying out spatial analyzes related to the areas, forest coverage, and specializing the project areas.

- In order to avoid double accounting of reduced and marketed emissions, an agreement has been signed with BioCarbon Standard that will guarantee proper coding of each transaction carried out and ensure accounting. Likewise, the project will comply with National regulations, specifically resolution 1447 of 2018, where it is required not only to register the project in its general conditions, but also to ensure each transaction developed.

15.2 Data and parameters to quantify the reduction of emissions.

15.2.1 Data and parameters determined at registration and not monitored during the monitoring period, including default values and factors

Data/Parameters	$A_{PLOT, i}, A_{SHRUB,i}, Ai$
Data Unit:	Ha
Description:	Area of the sampled plot; Stratum Area
Source of data:	Field Measurement
Value	0.05
Frequency of monitoring	At each check
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculations
Justification of choice of data or description of measurement methods and procedures applied	It was taken into account Calculation of the number of sample plots for measurements within A/R CDM Project activities.
Additional comments	N/A

Data/Parameters	*To*
Data Unit:	Ha

Data/Parameters	*To*
Description:	Stratum *I* Area
Source of data:	Field Measurement
Value	See Table 8 - Effectively existing and developing areas in the eligible project areas.
Frequency of monitoring	At each check
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculations
Justification of choice of data or description of measurement methods and procedures applied	A remote sensing process was developed, including Landsat 7 satellite images to ensure compliance with resolution requitements.
Additional comments	N/A

Data/Parameters	*APLOT,i*
Data Unit:	Ha
Description:	Total area of the sample plots in stratum *i*
Source of data:	Field Measurement
Value	0.05
Frequency of monitoring	At each check
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculations
Justification of choice of data or description of measurement methods and procedures applied	It was taken into account Calculation of the number of sample plots for measurements within A/R CDM Project activities
Additional comments	N/A

Data/Parameters	*$a_{p,i}$*
Data Unit:	m^2
Description:	Selected leaf litter sampling area in plot *p* in stratum *i*

Data/Parameters	$a_{p,i}$
Source of data:	Measurement
Value	0.50 - 1
Frequency of monitoring	Each verification (minimum every 2 years, maximum 5 years)
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculations
Justification of choice of data or description of measurement methods and procedures applied	A reference of 0.50 to 1^{m2} is often used for sampling of the selected leaf litter. In case of not having primary information, information from scientific literature may be used for the similar conditions of the project
Additional comments	N/A

Data/Parameters	$CC_{SHRUB, i}$
Data Unit:	Dimensionless
Description:	Shrub cover in stratum i of shrub biomass
Source of data:	Field Measurement
Value	0.5
Frequency of monitoring	Each verification (minimum every 2 years, maximum 5 years)
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculations
Justification of choice of data or description of measurement methods and procedures applied	Considering that biomass in shrubs is smaller than biomass in trees, a simplified method could be used to estimate canopy cover in shrubs. A visual estimation of coverage could be carried out either by any method such as the transect method or by using the relascope method.
Additional comments	When the land is subjected to a periodic cycle (e.g. slash and burn or clear regeneration) the shrub cover ranges between maximum and minimum values at baseline, on average the shrub cover is equal to 0.5 of the estimated biomass, unless the information provided is verifiable and transparent to justify a different value.

Data/Parameters	B_{LL_WET},p,i
Data Unit:	Kg
Description:	Wet weight of leaf litter sample collected from plot *p* of stratum *i*; kg.
Source of data:	Field Measurement on Sampling Plots
Value	See section 16.2.3.7.3
Frequency of monitoring	Each verification (minimum every 2 years, maximum 5 years)
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculations
Justification of choice of data or description of measurement methods and procedures applied	Quality control/quality assurance (QA/QC) procedures prescribed on the national forest inventory are applied. In the absence of these, the published manual of quality control/quality assurance procedures, or the IPCC GPG LULUCF 2003, may be applied
Additional comments	N/A

Data/Parameters	DAP
Data Unit:	Centimeter or any unit of length as specified
Description:	Diameter at chest height of a tree. To determine this, equations (1) and (2) are proposed, DBH could be any diameter or dimension measurement (e.g., basal diameter, root neck diameter, basal area, etc.) used as a data source for the model.
Source of data:	Field Measurement on Sampling Plots
Value	See annex Section 3 - Quantification of GHG emissions reduction\Quantifications\Ex post
Frequency of monitoring	Each verification (minimum every 2 years, maximum 5 years)
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculations

Data/Parameters	DAP
Justification of choice of data or description of measurement methods and procedures applied	Quality control/quality assurance (QA/QC) procedures prescribed on the national forest inventory are applied. In the absence of these, the published manual of quality control/quality assurance procedures, or the IPCC GPG LULUCF 2003, may be applied
Additional comments	N/A

Data/Parameters	Dn
Data Unit:	cm
Description:	Diameter of the *n* piece of dead (fallen) wood that intersects (or falls) with the transect. This applies to debris sampling
Source of data:	Field measurement along linear transects in sample plots
Value	See annex Section 3 - Quantification of GHG emissions reduction\Quantifications\Ex post
Frequency of monitoring	Each verification (minimum every 2 years, maximum 5 years)
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculations
Justification of choice of data or description of measurement methods and procedures applied	Quality control/quality assurance (QA/QC) procedures prescribed on the national forest inventory are applied. In the absence of these, the published manual of quality control/quality assurance procedures, or the IPCC GPG LULUCF 2003, may be applied
Additional comments	N/A

Data/Parameters	*H*
Data Unit:	Meter (m)
Description:	Tree Height
Source of data:	Field Measurement on Sampling Plots
Value	See annex Section 3 - Quantification of GHG emissions reduction\Quantifications\Ex post

Data/Parameters	*H*
Frequency of monitoring	Each verification (minimum every 2 years, maximum 5 years)
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculations
Justification of choice of data or description of measurement methods and procedures applied	Quality control/quality assurance (QA/QC) procedures prescribed on the national forest inventory are applied. In the absence of these, the published manual of quality control/quality assurance procedures, or the IPCC GPG LULUCF 2003, may be applied
Additional comments	N/A

Data/Parameters	*T*
Data Unit:	Year
Description:	The length of time between successive carbon storage estimates.
Source of data:	N/A
Value	See annex Section 3 - Quantification of GHG emissions reduction\Quantifications\Ex post
Frequency of monitoring	N/A
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculations
Justification of choice of data or description of measurement methods and procedures applied	N/A
Additional comments	If two of the successive estimates of carbon storage are taken to different points in a time in a year t2 and t1 (e.g., in April in year t1 and in September in year t2), then a fraction of value could be assigned to T

15.2.2   Data and parameters monitored.

Data/Parameters	$A_{PLOT, i}$, $A_{SHRUB,i}$, A_i
Data Unit:	Ha
Description:	Area of the sampled plot; Stratum Area
Measured /Calculated /Default:	Field Measurement
Source of data:	
Value(s) of monitored parameter	0.05
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculations
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Remote sensing
Measuring/ Reading/ Recording frequency	At each check
Calculation method (if applicable)	The standard operating procedures prescribed in the national forest inventory apply. In the absence of these, the manual published by SOPs, or that of IPCC GPG LULUCF 2003, will apply.
QA/QC procedures applied	Quality control/quality assurance (QA/QC) procedures prescribed on the national forest inventory are applied. In the absence of these, the published manual of quality control/quality assurance procedures, or the IPCC GPG LULUCF 2003, may be applied.

Data/Parameters	T_o
Data Unit:	Ha
Description:	Stratum *I* Area
Measured /Calculated /Default:	Field Measurement
Source of data:	
Value(s) of monitored parameter	See Table 8 - Effectively existing and developing areas in the eligible project areas.

Data/Parameters	*To*
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculations
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Remote sensing
Measuring/ Reading/ Recording frequency	At each check
Calculation method	The standard operating procedures prescribed in the national forest inventory apply. In the absence of these, the manual published by SOPs, or that of IPCC GPG LULUCF 2003, will apply.
QA/QC procedures applied	Quality control/quality assurance (QA/QC) procedures prescribed on the national forest inventory are applied. In the absence of these, the published manual of quality control/quality assurance procedures, or the IPCC GPG LULUCF 2003, may be applied.

Data/Parameters	*APLOT,i*
Data Unit:	Ha
Description:	Total area of the sample plots in stratum *i*
Measured /Calculated /Default:	Field Measurement
Source of data:	
Value(s) of monitored parameter	0.05
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculations
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Remote sensing

Data/Parameters	*APLOT,i*
Measuring/ Reading/ Recording frequency	At each check
Calculation method	The standard operating procedures prescribed in the national forest inventory apply. In the absence of these, the manual published by SOPs, or that of IPCC GPG LULUCF 2003, will apply.
QA/QC procedures applied	Quality control/quality assurance (QA/QC) procedures prescribed on the national forest inventory are applied. In the absence of these, the published manual of quality control/quality assurance procedures, or the IPCC GPG LULUCF 2003, may be applied.

Data/Parameters	$a_{p,i}$
Data Unit:	m^2
Description:	Selected leaf litter sampling area in plot *p* in stratum *i*
Measured /Calculated /Default:	Measurement
Source of data:	Measurement
Value(s) of monitored parameter	0.50 - 1
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculations
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	A reference of 0.50 to 1m^2 is often used for sampling of the selected leaf litter. In case of not having primary information, information from scientific literature may be used for the similar conditions of the project
Measuring/ Reading/ Recording frequency	Each verification (minimum every 2 years, maximum 5 years)
Calculation method	The standard operating procedures prescribed in the national forest inventory apply. In the absence of these, the manual published by SOPs, or that of IPCC GPG LULUCF 2003, will apply.

Data/Parameters	$a_{p,i}$
QA/QC procedures applied	Quality control/quality assurance (QA/QC) procedures prescribed on the national forest inventory are applied. In the absence of these, the published manual of quality control/quality assurance procedures, or the IPCC GPG LULUCF 2003, may be applied.

Data/Parameters	$CC_{SHRUB, i}$
Data Unit:	No dimensions
Description:	Shrub cover in stratum *i* of shrub biomass
Measured /Calculated /Default:	Field Measurement
Source of data:	
Value	0.5
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculations
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	When the land is subjected to a periodic cycle (e.g. slash and burn or clear regeneration) the shrub cover ranges between maximum and minimum values at baseline, on average the shrub cover is equal to 0.5 of the estimated biomass, unless the information provided is verifiable and transparent to justify a different value.
Measuring/ Reading/ Recording frequency	Each verification (minimum every 2 years, maximum 5 years)
Calculation method	Considering that biomass in shrubs is smaller than biomass in trees, a simplified method could be used to estimate canopy cover in shrubs. A visual estimation of coverage could be carried out either by any method such as the transect method or by using the relascope method.
QA/QC procedures applied	Quality control/quality assurance (QA/QC) procedures prescribed on the national forest inventory are applied. In the absence of these, the published manual of quality control/quality assurance procedures, or the IPCC GPG LULUCF 2003, may be applied.

Data/Parameters	B_{LL_WET},p,i
Data Unit:	Kg
Description:	Wet weight of leaf litter sample collected from plot *p* of stratum *i*; kg.
Measured /Calculated /Default:	Field Measurement on Sampling Plots
Source of data:	
Value(s) of monitored parameter	See section 16.2.3.7.3
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculations
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	The standard operating procedures prescribed in the national forest inventory apply. In the absence of these, the manual published by SOPs, or that of IPCC GPG LULUCF 2003, will apply.
Measuring/ Reading/ Recording frequency	Each verification (minimum every 2 years, maximum 5 years)
Calculation method	The standard operating procedures prescribed in the national forest inventory apply. In the absence of these, the manual published by SOPs, or that of IPCC GPG LULUCF 2003, will apply.
QA/QC procedures applied	Quality control/quality assurance (QA/QC) procedures prescribed on the national forest inventory are applied. In the absence of these, the published manual of quality control/quality assurance procedures, or the IPCC GPG LULUCF 2003, may be applied.

Data/Parameters	DAP
Data Unit:	cm or any unit of length as specified
Description:	Diameter at chest height of a tree. To determine this, equations (1) and (2) are proposed, DBH could be any diameter or dimension measurement (e.g., basal diameter, root neck diameter, basal area, etc.) used as a data source for the model.
Measured /Calculated /Default:	Field Measurement on Sampling Plots

Data/Parameters	DAP
Source of data:	
Value(s) of monitored parameter	See annex Section 3 - Quantification of GHG emissions reduction\Quantifications\Ex post
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculations
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Measuring tapes
Measuring/ Reading/ Recording frequency	Each verification (minimum every 2 years, maximum 5 years)
Calculation method (if applicable)	The standard operating procedures prescribed in the national forest inventory apply. In the absence of these, the manual published by SOPs, or that of IPCC GPG LULUCF 2003, will apply.
QA/QC procedures applied	Quality control/quality assurance (QA/QC) procedures prescribed on the national forest inventory are applied. In the absence of these, the published manual of quality control/quality assurance procedures, or the IPCC GPG LULUCF 2003, may be applied.

Data/Parameters	Dn
Data Unit:	cm
Description:	Diameter of the n piece of dead (fallen) wood that intersects (or falls) with the transect. This applies to debris sampling
Measured /Calculated /Default:	Field measurement along linear transects in sample plots
Source of data:	
Value(s) of monitored parameter	See annex Section 3 - Quantification of GHG emissions reduction\Quantifications\Ex post
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculations

Data/Parameters	Dn
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Measuring tapes
Measuring/ Reading/ Recording frequency	Each verification (minimum every 2 years, maximum 5 years)
Calculation method	The standard operating procedures prescribed in the national forest inventory apply. In the absence of these, the manual published by SOPs, or that of IPCC GPG LULUCF 2003, will apply
QA/QC procedures applied	Quality control/quality assurance (QA/QC) procedures prescribed on the national forest inventory are applied. In the absence of these, the published manual of quality control/quality assurance procedures, or the IPCC GPG LULUCF 2003, may be applied.

Data/Parameters	H
Data Unit:	Meter (m)
Description:	Tree Height
Measured /Calculated /Default:	Field Measurement on Sampling Plots
Source of data:	
Value(s) of monitored parameter	See annex Section 3 - Quantification of GHG emissions reduction\Quantifications\Ex post
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculations
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Clinometer
Frequency of monitoring	Each verification (minimum every 2 years, maximum 5 years)

Data/Parameters	*H*
Calculation method	The standard operating procedures prescribed in the national forest inventory apply. In the absence of these, the manual published by SOPs, or that of IPCC GPG LULUCF 2003, will apply.
QA/QC procedures applied	Quality control/quality assurance (QA/QC) procedures prescribed on the national forest inventory are applied. In the absence of these, the published manual of quality control/quality assurance procedures, or the IPCC GPG LULUCF 2003, may be applied.

16 Quantification of GHG emission reduction / removals

16.1 Baseline emissions

The removal balances for the baseline are defined by:

$$\Delta C_{BSL,t} = \Delta C_{TREE_{BSL,t}} + \Delta C_{SHRUB_{BSL,t}} + \Delta C_{DW_{BSL,t}} + \Delta C_{LI_{BSL,t}}$$

Where:

$\Delta C_{BSL,t}$ =   Baseline net GHG removals by sinks in year *t*; t CO_2-e

$\Delta C_{TREE\_BSL,t}$ =   Change in carbon stock in baseline tree biomass within the project boundary in year t, as estimated in the tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"; t CO_2-e

$\Delta C_{SHRUB\_BSL,t}$ =   Change in carbon stock in baseline shrub biomass within the project boundary, in year t, as estimated in the tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" t CO_2-e

$\Delta C_{DW\_BSL,t}$ =   Change in carbon stock in baseline dead wood biomass within the project boundary, in year t, as estimated in the tool "Estimation of carbon stocks and change in carbon stocks in deadwood and litter in A/R CDM project activities"; t CO_2-e

$\Delta C_{LI\_BSL,t}$ =   Change in carbon stock in baseline litter biomass within the project boundary, in year t, as estimated in the tool "Estimation of carbon stocks and change in carbon stocks in deadwood and litter in A/R CDM project activities; t CO2-e

The carbon stocks in the Baseline scenario correspond to those stored in the biomass of the plant species present in the areas identified as eligible. As established in the previous chapters, the eligible areas corresponded to those areas covered by unmanaged grasses or savannahs that have historically been subjected to continuous burning; the presence of trees or shrubs is not evident since the burning restricts their permanent presence.

In this way, according to Rao et al (2001) the productivity ranges of the native savannah grasses of the Orinoquía range on average between 3.60 and 5.22 tons of dry matter per hectare (t MSha-1), considering the biomass above the ground and under it. Assuming that 50% of the weight of this biomass is carbon (Intergovernmental Panel on Climate Change (IPCC), 2003), it is defined that these covers present 1.80 and 2.61 tons of carbon per hectare (t C ha-1), respectively.

It is noteworthy that authors such as Rippstein et al (2001) have identified that the pasture and savannah covers of the Colombian highlands are very old, which allows us to assert that it is likely that the biomass of the native vegetation that has been subjected to historical slashing and burning processes remain at stable average values, generating a certain dynamic balance. This suggests that even after intervention processes, the biomass of the existing vegetation recovers quickly to maintain said balance, but not beyond the supply of environmental resources provided to the ecosystem (limits due to soil fertility, degree of degradation and alteration of soil horizons and also the levels of chemical and physical indicators of the soil, among others). With this hypothesis and wanting to model the behavior of recovery and accumulation of the carbon produced (t C ha-1) in the biomass of the pastures, the biomass information (aerial and root) collected in the Carimagua region (Department of Meta) by Rao et al. (2001), for different alterations and variation in rest periods (weeks) after slash and burn. To determine its growth and biomass accumulation, the Bertalanffy growth model was used (C = A[1−exp(-bt)] 1/(1-m), Equation 1., later) that describes the growth of the individual (living organism) depending on the life span. The cloud of carbon points and the model trend indicate that after felling, the carbon of the native vegetation stabilizes quickly around the fifth week, towards a constant value of 2.37 t C ha-1 (Figure 7). The results allow us to conclude that, indeed, after the intervention processes, the aerial biomass of the native vegetation recovers quickly and remains stable.

For its part, a study carried out in Carimagua region (Department of Meta) in introduced and poorly managed pastures concluded that this type of coverage produces 2.9 t C ha-1year-1 after 17 years of establishment. Apparently, these pastures incorporate greater amounts of carbon compared to savanna vegetation (Fisher, 1994). However, various authors affirm that the net growth in introduced pastures is limited to the first years of their establishment. For example, in poorly managed pastures in "*Cerrado Biome*" (Brazil), initial net accumulation rates were high and were associated with considerable increases in carbon incorporation. However, the respiration rates of soil microorganisms compensated for these gains over time (Davidson E. A., 1995), but for the Orinoquia region of Colombia, the strong degradation and burning of soils reduces the macrobiotic activity of the soils, reducing the effectiveness of the compensation.

The equation shown on the graph: $2{,}37(1\text{-}exp(\text{-}1{,}43t)^{2.93}$
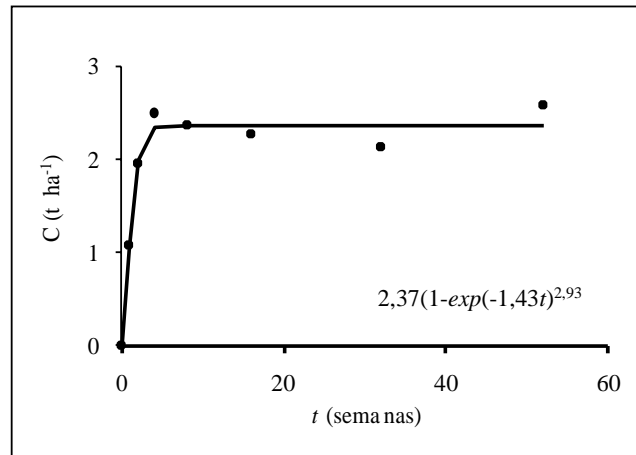
Figure 7 - Carbon production in native savannahs and unmanaged pastures in the Colombian eastern plains region, estimate developed for one year of analysis

Note: The beginning of the analysis corresponds to the rest period between two cutting and burning of the non-forest cover. The black dots are the carbon values corresponding to the biomass reported by Rao et al. (2001), after assuming 50% carbon in the biomass. The solid line corresponds to the estimates made using the von Bertalanffy model.

Regarding the average residence period of the carbon contained in the biomass in this type of savannas, it is 10 years when it is not altered, and authors such as (Trumbore, 1995) have estimated that the annual rates of carbon accumulation at 20 years decrease by about of 10% of the net accumulation observed during the first three years of growth. The aforementioned evidence then suggests that carbon incorporation in savannahs reaches constant, or even negative, values, both for savannahs and introduced pastures.

In this way, it is assumed that the carbon incorporated in the baseline for the Proyecto de Carbono Forestal Vichada Alianza Fiduciaria S.A. initiative is between the extreme content values mentioned, that is, 1.8 and 2.9 tCha-1, and is within the values of aboveground and belowground biomass incorporated in different pastures of the tropical region (1.8 and 5.0 t C ha-1) reported IPCC (2003).

Finally, accepting the recommendations of the AR-Tool14 tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities", in its literal 5, paragraph 12, consideration f, recommends assuming the removals of the baseline as zero when:

> f) Land is subjected to periodic cycles (e.g. slash-and-burn, or clearing-regrowing cycles) so that the biomass oscillates between a minimum and a maximum value in the baseline.

Besides, it is also highlighted that the three conditions for accounting the removals of the baseline as zero indicated in literal 5, paragraph 12 of AR-Tool14 are met as follows:

a) The pre-project trees are neither harvested, nor cleared, nor removed throughout the crediting period of the project activity; since, the pre-project the trees have been planted by the project but were not included in the Project emissions, as it is clarified in Section 3.2.3 of PD.

b) 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; since, the pre-project the trees have been planted by the project, but have not been included in project emissions nor have they been removed or suffered mortality, as it is clarified in Section 3.2.3 of PD.

c) 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; since, the pre-project the trees have been planted by the project, but have not been included in project emissions nor have they been removed or suffered mortality, as it is clarified in Section 3.2.3 of PD.

As detailed, the burning activity in the grasslands of the Colombian plain is a cultural practice that has been developed for decades and includes the project areas. These burns have been documented and have been the center of discussion for their prohibition or management[5], and recommendations have been developed to prevent their presence and spread. According to the above, changes in baseline removals are assumed to be zero.

Despite the above, it is important to clarify that, as it was explained in section 3.5 of the PD, to manage uncertainty Table 3 "Discounts for quality and applicability of GHG

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[5] http://www.humboldt.org.co/images/pdf/notibita/notibita-06-web.pdf

- https://elmorichal.com/tag/incendio-forestal-vichada/
- https://es.mongabay.com/2019/07/incendios-norte-amazonia-deforestacion-colombia/
- https://www.contextoganadero.com/regiones/quemas-reducen-el-carbono-organico-del-suelo-en-la-orinoquia

estimation models" of the BCR0001 methodological tool was taken into account in the project calculations.

16.2 Project emissions/removals

To subject the project to the process of verification of removing emissions, activities are developed to determine the emissions removed by the establishment of forest plantations and the development of natural regeneration (stand models) within the eligible areas.

As a first step, an analysis of the established areas and their development was carried out. On these areas, in order to apply the processes defined by the BCR0001 methodology (which is based on AR-ACM0003 methodology[6]) in the estimation of carbon captured by reforestation activities, a staging was developed with which the areas are separated according to their biomass/carbon content in the established areas. Likewise, an advance analysis of the passive natural regeneration cover was carried out for the respective carbon sequestration analyses. However, this stratum has not shown significant progress compared to the contents of the baseline (savannah grasslands).

Compared to the hectares established by each stand model, only the commercial one with the presence of forest cover was characterized for the species considered, *P. caribaea.* For the natural regeneration component, no significant increases in coverage and therefore in carbon accumulation were identified, so this stratum is not accounted for the current monitoring period.

16.2.1 Results of stratification for carbon estimation

This process is developed to separate areas that have differences in their biomass contents. Given that the staging function is based on the capacity to capture carbon and how it is maintained in the reservoirs of the forest (aboveground biomass, underground biomass and soil organic carbon), it is important to make this differentiation focused on having coherent and accurate balances of CO_2 removals. However, the project presents differences between species, years of sowing and stand models (Commercial and Natural Regeneration), conditions such as soil, environmental supply, type of seeds, among others.

The stratification process was based on recent satellite images, which allowed classifications to be made according to the spectral response according to the amount

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[6] Afforestation and reforestation of lands except wetlands - Version 2.0

of associated coverage. Likewise, in order to give a better adjustment to the stratification process, the results of a grid of plots established in the lots of the projects were taken, in this way it was possible to make a field validation of the interpreted coverages. The process and its results are presented below.

16.2.2 Process for the quantification of areas and strata of forest plantation development

In order to quantify the amounts of carbon sequestered in forest plantations established in four projects located in La Primavera, Vichada, Colombia; Geomatics tools are used to determine the land cover identified with forest plantation areas and additionally a stratification is established between the development stages of the different crops, since the amount of carbon sequestered is proportional to the volume of biomass found in the trees. This process was corroborated with the data acquired in the field, through the establishment of monitoring plots, in which basic aspects of the plantation were measured, such as height, diameter at breast height (DAP), species, location, among others.

16.2.3 Description of the process for determining planted areas

The process of quantifying areas and determining stages of development can be summarized in five major steps, as described in the following diagram:
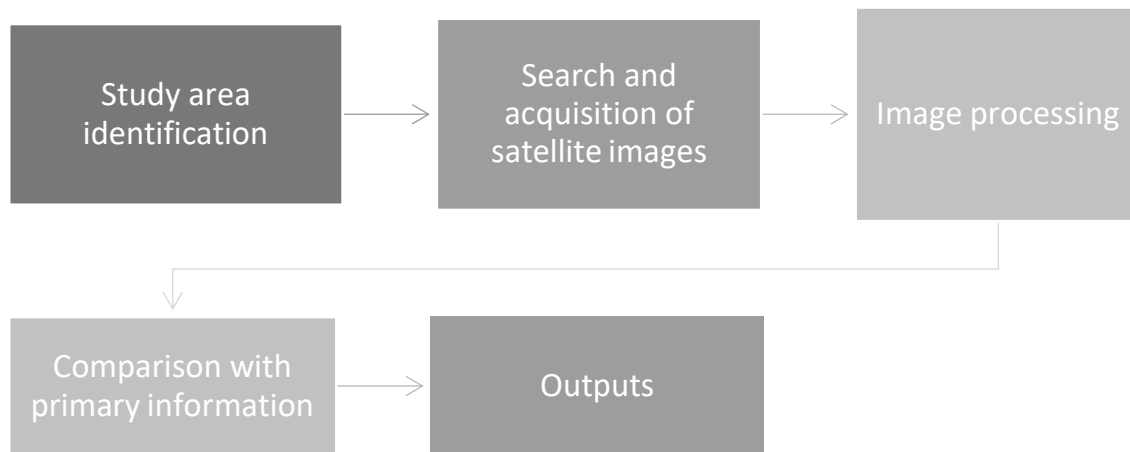
Figure 8 – Methodology Implemented

16.2.3.1 Study area identification.

The first step in any spatial analysis is the identification of the study area. In this case, and as the forest carbon initiative is developed, it was determined to carry out the joint analyses for four nuclei that develop the forest carbon initiative, which although they are typified as a regional umbrella project and share aspects related to silvicultural management, since they are covered by the same technical assistance of the La

Primavera forestry nucleus, They decide to develop their own project documents and monitoring reports separately, but with unified analyses for all four, in order to facilitate processes and generate economies of scale of the carbon project.

In this way, the project area is defined as the properties that make up each of the projects developed in the municipality of La Primavera, Vichada, Colombia (Figure 9).

Figure 9 - General location of forest carbon initiatives in the La Primavera core

It should be noted that the region has very similar conditions throughout its extension, characteristics such as heights above mean sea level, slopes with little gradient, meandering drainages, relicts of gallery forests located along the springs and simple drainages that progressively feed the larger drainages, the composition of soils and the landscapes and ecosystems of savannah; describe the particularities of the eastern plain of the country.

16.2.3.2   Search and acquisition of satellite imagery

In accordance with the provisions of the digital image processing protocol for the quantification of deforestation in Colombia (Galindo, Espejo, Rubiano, Vergara, & Cabrera , 2014), the LANDSAT 7 satellite images (path 05 and row 56) must be selected and downloaded from the Earth Resources Observation and Science Center - EROS server of the United States Geological Survey - USGS through the Glovis viewer for the years 2013, 2018 and 2019.

16.2.3.3   Image Processing

Once the satellite images needed for the analysis were downloaded, they were pre-processed using ArcGIS 10.8 software.

16.2.3.3.1   Error Handling

To correct the error called 'scan line', caused by the failure of the scan line corrector (SLC), we initially proceeded to apply the 'Is Null' tool to fill the empty null spaces with the value 1, followed by the 'Con' tool to return the rest of the original values to the band.

Subsequently, with the help of the 'Landsat Toolbox' available at the following link: Landsat Toolbox, the 'Fix Landsat 7 Scanline Errors' tool was applied to correct the errors for each band of interest. It is important to note that a modification of the last-mentioned tool was made, where for the application of the 'Set Null' function the expression was left as follows to follow the logic made with the two previous tools: '*Value = 1*'.

16.2.3.3.2   Band Composition

Since the bands that make up the satellite image are downloaded in different files, it is necessary to stack the bands of interest; in this case the composition of bands was executed by means of the raster file processing tool 'Composite bands', considering bands 3, 4 and 5, these being the ones recommended for vegetation analysis.

16.2.3.3.3   Definition of the work area.

Taking into account the large size of the satellite images, a crop of the area of interest was made using the raster file processing tool '*Clip*'.

16.2.3.3.4   Geometric correction

In order to respect the country's official reference system MAGNA-SIRGAS, the projection of each satellite image already composed was carried out by means of the raster file projection and transformation tool '*Project Raster*'.

16.2.3.3.5   NDVI

Within the processing of satellite images there are several indices by means of which spectral enhancements of certain coverages are made, as is the case of the normalized

vegetation index (NDVI), used to measure the normalized difference between the reflectance of the red and the near infrared, providing a measure of the quantity, quality and development of vegetation cover and vigorousness over large areas.
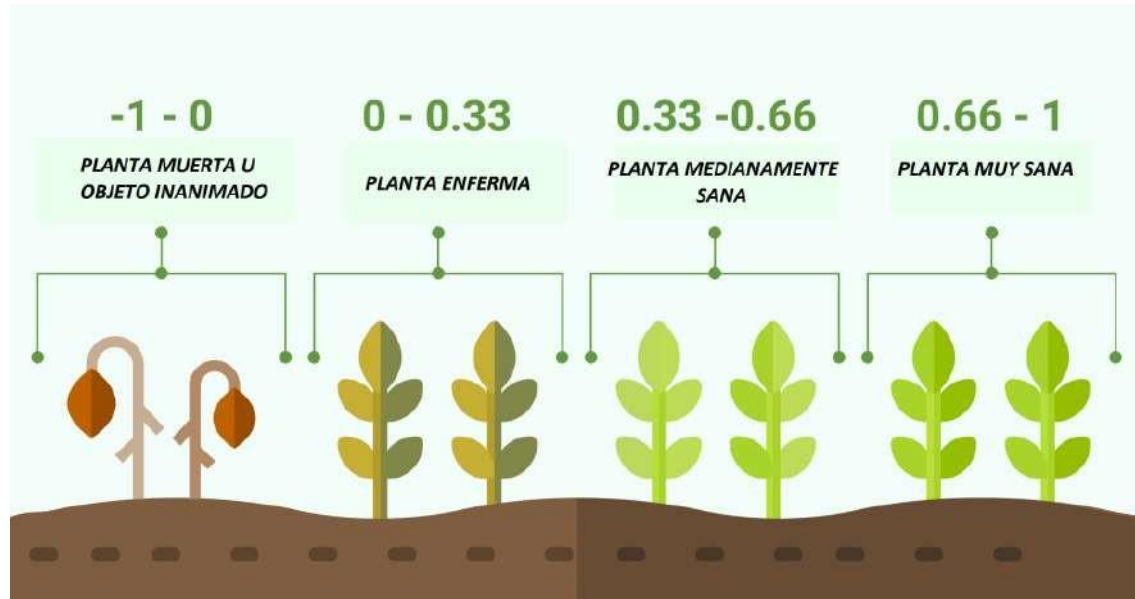
Figure 10 – NDVI - Normalized vegetation index

To determine this index, the formula indicated by the United States Geological Survey was applied by means of the 'Raster calculator' tool, which establishes the following equation for Landsat 4 – 7 images:

$$NDVI = \frac{(Band4 - Band\,3)}{(Band\,4 + Band\,3)}$$

As for the possible outcomes, it is important to clarify that the values of this index range from +1.0 to -1.0, where areas with rocky, sandy, or sterile snow cover generally show very low NDVI values (e.g., 0.1 or less); scattered vegetation such as shrubs and grasslands or crops may result in moderate NDVI values (approximately 0.2 to 0.5). Finally, high NDVI values (approximately 0.6 to 0.9) correspond to dense vegetation such as that found in temperate and tropical forests.

16.2.3.4   Comparison with primary information

To increase the quality criteria of the process and further adjust the information to the reality found in the field, the data obtained in the surveys of plots were added as samples to the seeding process and were considered in the manual editing phase of the classification, thus, the statistical sample is increased without systematic errors. By reducing the variances between the classes to be classified, which it should be clarified, as they all respond to plantation covers, they can present similarities in their spectral

responses, and thus achieve low correlations between the training areas and the resulting classes.

The field plots were classified considering their amount of carbon sequestration, calculated based on the amount of biomass found.

16.2.3.5   Results

Once all the processes described above have been carried out, the result is the stratification into two stages of development of the forest plantations established in the projects.

- Low
- Regular
- Middle
- High

These strata can be identified in the following thematic maps for the four nuclei in which the distribution of the sample and the field inventory work were carried out in the same way.
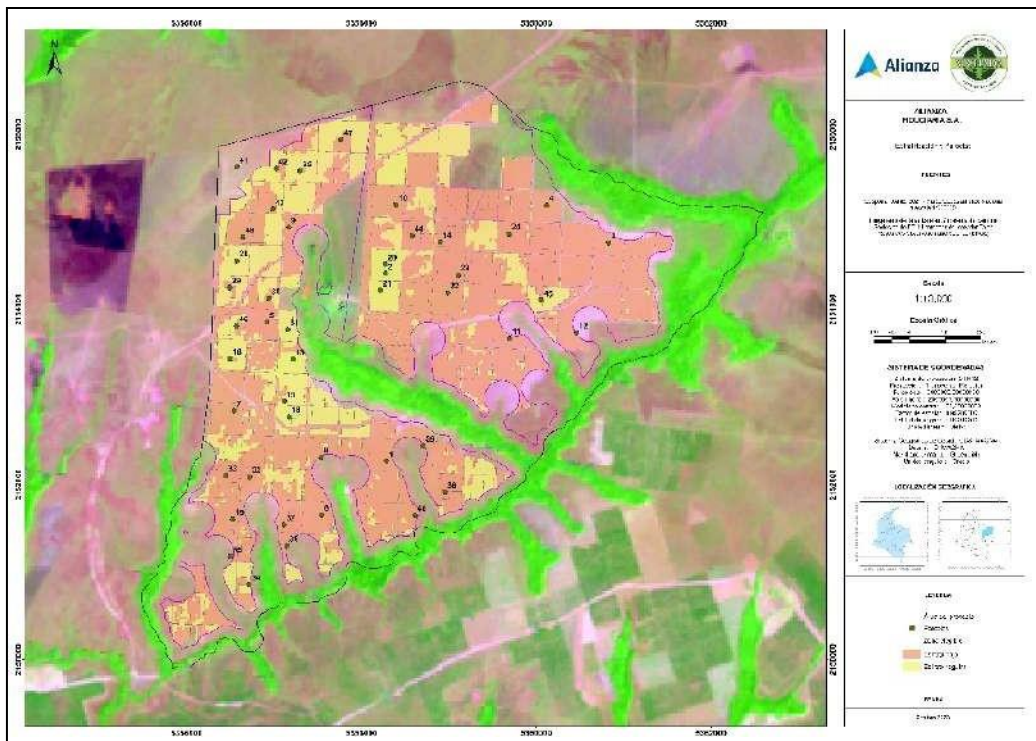
Figure 11 - Stratification and plots Proyecto de Carbono Forestal Vichada Alianza Fiduciaria S.A.

16.2.3.5.1 Stratification

Although the eligible area within the project is 1,645.85 eligible hectares, it was estimated that by 2019 all areas of the commercial stand model should have been established, however as a conservative position within the remote sensing analysis, only the areas that show a condition of advanced development or because some died and were in replanting processes, also because the analysis of satellite images itself discounts the areas within the plots that showed mortality. Therefore, in the ex-post analyzes the areas for the two identified strata they are lower than the projected planted areas (289.6 hectares less reported in the present analysis).

Table 8 - Effectively existing and developing areas in the eligible project areas.

Proyecto de Carbono Forestal Vichada Alianza Fiduciaria S.A.	
Stratum	Area (Ha)
Low	902.47
Regular	419.27
Total general	1,321.74

16.2.3.6 Field inventory results

From the stratification and its areas, a sample size distribution was developed following the methodological recommendations of the UNFCCC for CDM reforestation project.

Only plots with the species of *Pinus caribaea* were considered. A total of 145 plots were established distributed in the four strata of the total sampling, as follows.

Table 9 - Sample number inventoried in the sampling of the strata.

Stratum	Established Plots
Low	74
Regular	19
Middle	38
High	14
Total	145

The number of plots according to stratum is presented for each of the nuclei in the following table.

Table 10 - Proyecto de Carbono Forestal Vichada Alianza Fiduciaria S.A. Plots

PORTION	STRATUM	PORTION	STRATUM
FID001	Low	FID029	Low

PORTION	STRATUM	PORTION	STRATUM
FID003	Low	FID030	Low
FID004	Low	FID031	Low
FID005	Low	FID032	Low
FID006	Low	FID033	Low
FID007	Low	FID034	Low
FID008	Low	FID035	Low
FID009	Low	FID036	Low
FID010	Low	FID037	Low
FID011	Low	FID038	Low
FID012	Low	FID039	Low
FID013	Low	FID040	Low
FID014	Low	FID041	Low
FID015	Low	FID042	Low
FID016	Low	FID043	Low
FID018	Low	FID044	Low
FID019	Low	FID045	Low
FID020	Low	FID046	Low
FID022	Low	FID047	Low
FID023	Low	FID048	Low
FID024	Low	FID002	Regular
FID025	Low	FID021	Regular
FID028	Low		

16.2.3.7 Belowground and Groundwater Carbon Estimates

For the estimates of accumulated carbon per hectare, we used equations available in the literature, which were for the species and variety (if possible) of trees considered in the plantation and following the default values and procedures established by the IPCC (2003, 2006) when applicable. All the results described here can be found in the Excel tool Section 3 - Quantification of GHG emissions reduction/Quantifications/ Ex-post 2018 - 2019.xlsx.

Pinus Caribaea	Seedlings or trees less than 2 cm of DAP or without DAP.	A value of 0.1125 kg of biomass per tree applies. This value was obtained by destructive sampling in the same plantations.
	Trees from 0.6 cm to 56 cm DAP.	$BA=0.887+[(10486*DAP^{2.84}/(DAP^{2.84})+376907)]$

		Equation cited by IPCC 2003.[7]

*DAP: Diameter at chest height (1.3 m) above the ground. BA: Biomass (kg), ht: total height of the tree.

$$RJ = \frac{e - /.1234 1.2256 * lnb}{b}$$

Where:

Rj: Root-shoot biomass relationship for species j; dimensionless

b Aboveground biomass per hectare (en t d.m. ha^{-1}),

j 1, 2, 3, … specie

The carbon content in the underground component was estimated following the methodological recommendations of the IPCC 2003, which determines different factors to be applied according to the biomass contents per hectare and for each species. It is important to clarify that only in the 2003 IPCC Good Practice Guidelines, specific reference is made to what factors to make use of for root biomasses in coniferous plantations and plantations of eucalyptus and other broadleaf species.

Table 11 -Root-shoot relationship

Coverage	Aboveground Biomass Reference ($^{THA-1}$)	Factor R. (*Root-shoot relationship*)
Conifer Plantations	<50	*0.46*
	50-150	*0.32*
	>150	*0.23*

16.2.3.7.1 Estimation of the sample quantity

Winrock's CDM A/R Sample Plot Calculator Spreadsheet Tool was used for estimation, which applies equations and statistics to sample size estimation. The tool makes use of an error level of 10% as a maximum and a confidence level of 90% as a minimum.

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[7] IPCC. 2003. Annex 4. Section 4.2. Examples of allometric equations for estimating the biomass of above-ground and below-ground trees.

The following table shows the minimum parcel results for each project and stratum, and the actual number of parcels set.

Table 12 - List of sampling units (plots) established in the Proyecto de Carbono Forestal Vichada Alianza Fiduciaria S.A., in La Primavera, Vichada

Stratum	Plots per stratum required in each project (at least 3 per stratum is defined)	Established Plots
Low	15	74
Regular	17	19
Total		**93**

A total of 93 rectangular plots were set up, each with an area of 500 m2 in the areas where the commercial stand model or forest plantations have been established. In this period of monitoring and verification, although the passive natural regeneration stand model was considered, it will not be quantified due to the low development that has been identified by satellite images, assuming for this stratum and for the present verification, a conservative position regarding the removal of carbon derived from this stand or stratum model.

In the current monitoring period, only the plots of the low and regular strata that dominated the plantations of the Proyecto de Carbono Forestal Vichada Alianza Fiduciaria S.A. were considered. In this way, and in accordance with the previous table, the minimum sample size established by the methodology is met.

As described in previous paragraphs, information from 93 plots in the two strata was used (see annex Section 3 - Quantification of GHG emissions reduction\Quantifications\Ex post). The number of plots, as well as their proper coding, results and general statistics are shown in Table 13.

It should be noted that, according to the methodological tool, estimates are made at a discount to the average when the uncertainty of the analyses exceeds 10%, per stratum.

Table 13 -Result of the estimates of aboveground biomass (tha⁻¹) by plot and stratum

Low		Regular	
Cod Parcel	CO_2 $^{ha-1}$	Cod Parcel	CO_2 $^{ha-1}$
dor007	1.695	dor002	33.980
dor008	1.085	dor009	48.877
dor014	1.619	dor011	45.560
dor015	0.683	dor023	47.810
dor016	0.825	dor026	44.292
dor017	1.221	dor028	34.385

Low		Regular	
Cod Parcel	CO_2 $^{ha-1}$	Cod Parcel	CO_2 $^{ha-1}$
dor018	1.743	dor029	42.772
dor019	0.041	dor039	63.015
dor021	0.623	dor040	65.563
dor022	0.354	dor041	64.148
dor025	0.694	dor048	13.505
dor030	0.334	FID002	14.483
dor033	2.021	FID021	13.501
dor034	0.561	olp_001A	14.167
dor035	0.536	olp_002A	13.125
dor036	2.156	olp_004A	10.189
dor037	0.050	olp_005A	12.674
dor038	1.052	olp_021	18.673
dor042	5.704	red_004	19.428
dor043	0.887		
dor044	2.262		
dor047	0.396		
dor049	0.252		
dor051	0.045		
dor052	0.700		
dor054	0.732		
dor055	1.581		
FID001	2.217		
FID003	1.168		
FID004	0.721		
FID005	1.790		
FID006	4.144		
FID007	5.148		
FID008	1.393		
FID009	2.497		
FID010	2.955		
FID011	4.026		
FID012	3.136		
FID013	2.248		
FID014	0.754		
FID015	2.525		
FID016	4.120		
FID018	4.912		
FID019	3.445		

Low		Regular	
Cod Parcel	CO_2 $^{ha-1}$	Cod Parcel	CO_2 $^{ha-1}$
FID020	5.052		
FID022	2.488		
FID023	1.860		
FID024	2.009		
FID025	3.727		
FID028	2.096		
FID029	3.781		
FID030	2.454		
FID031	5.504		
FID032	4.193		
FID033	1.529		
FID034	4.430		
FID035	3.644		
FID036	3.112		
FID037	1.600		
FID038	1.300		
FID039	3.770		
FID040	2.590		
FID041	2.819		
FID042	2.702		
FID043	1.431		
FID044	0.567		
FID045	0.824		
FID046	2.113		
FID047	1.526		
FID048	4.792		
olp_007A	0.313		
olp_008A	0.975		
olp_009A	1.382		
olp_022	2.101		
dor007	1.695		
dor008	1.085		
dor014	1.619		
dor015	0.683		
dor016	0.825		
dor017	1.221		
dor018	1.743		
dor019	0.041		

Low		Regular	
Cod Parcel	**CO$_2$ $^{ha-1}$**	**Cod Parcel**	**CO$_2$ $^{ha-1}$**
Average	2.078		14.143
Adjusted Average	1.49		12.91
Stand Desv	1.478		3.85
Variance	2.185		9.519
N	74		19
Standard Error Medium	0.17	Regular Statisticians	0.71
Uncertainty	13.8%		8.3%
Discount to	0.59		1.23
T student (90%)	1.666		1.666

Note: "Low Statisticians" label appears in the leftmost column spanning the data rows.

*Discounts to the average are applied following BCR requirements, considering the 40% discount of the standard deviation, as the estimate comes from biomass equations proposed by the literature (IPCC, 2003).

16.2.3.7.2 Soil Organic Carbon.

For this estimation it was applied "*Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities*".

This tool, depending on the conditions of the pre-existing soil material in the project area, its management and state of degradation, sets a value for each hectare that is part of the project defined by the following equation.

$$\Delta SOC = \frac{44}{12} \big) A_i * dSOC_{t,i} * 1 year$$

ΔSOCAL,t: Change in soil organic carbon contents t C ha^{-1} yr^{-1}.
dSOC: Annual rate of change of soil organic carbon content. t C ha^{-1} yr^{-1}.
A$_i$:   Area of each stratum of the project ha.
I: Stratum *i*

For this estimation, the *Excel* tool " COS ARWG30_SOC_Tool_Multizones_FID.xlsx" was used, which applies the established procedures mentioned in the "*Tool for*

estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities".

Under the conditions of the project areas*, dSOC = 0.8* per hectare per year. This value, multiplied by 44/12 results in a change of 2.93333 tCO2 per hectare per year in the soil carbon sink. The results for the cumulative areas as of 2019 are shown in Table 14.

Table 14 - Estimation of soil organic carbon.

Year	Area (ha)	Cumulative area (ha)	CO₂ (t)
2018	45,51	45,51	4815,65
2019	0,00	45,51	4815,65
			9.631,31

16.2.3.7.3 Other sinkholes

Shrubbery.

They were estimated following the methodological recommendations and making use of the default factors determined by the methodological tools. This component assumes a relationship of aboveground biomass content for the types of natural forests present in the project area and related to the areas established for each year of intervention. The balances for this component are shown in the following table.

Table 15 - Carbon content estimates for the project's shrub sink

Year	Sowing has	2015	2016	2017	2018	Sum
		838.70	384.92	82.95	45.51	1,352.08
	2018	2035	940	212	0	3,187.1
	2019	2035	940	212	1272	4,459.1
						7.646,2

Litter

For litter, although this component was not directly measured in the present verification, the indirect processes considered by the methodological tool Estimation of carbon stocks and *change in carbon stocks in dead wood and litter in A/R CDM project activities V* were used. *03.1. The estimates* are assumed from the results of the carbon content of the trees present in each stratum ($C_{tree,i,t}$), multiplied by a conversion factor, $DF_{LI,}$ *which expresses the carbon content present in the leaf litter as a percentage of the content identified in the biomass of the trees.* Although the methodological tool recommends a general factor, it suggests applying other values when these are based on analyses carried out specific to the project space under similar conditions. For leaf litter, the factor

of 10% was assumed, which is the result of the average values identified in other studies for the species of *Pinus sp* in the tropical region (Section 3 - Quantification of GHG emissions reduction/Quantifications/ Ex-post 2018 - 2019.xlsx).

Table 16 - Estimates of carbon reductions (tCO2 ha-1) of the leaf litter component in the current monitoring period

DF_{LI}	10%	
Stratum	Area (Ha)	Leaf litter C $_{LI,t}$ (tCO2)
Low	902,47	333
Regular	419,27	919
Total		**1.252**

Dead wood.

It is estimated from default values recommended by the methodological tool. This tool suggests an expansion factor of 6%, which relates the dead wood above the ground to the above-ground carbon in each stratum. This average value was multiplied by the areas of each stratum in the monitored project area.

The estimated deadwood carbon results per hectare are shown in the following table.

Table 17 - Estimates of carbon per hectare in the biomass component of dead wood on the ground.

DF_{DW}	6%
Stratum	$C_{DW,i,t}\ ha^{-1}$
Low	200
Regular	551
Total	**751**

16.3 Leakage

These are related to the displacement of activities carried out within the scope of the project to areas outside the scope of the project. The project, as conceived, does not foresee the production of leaks due to displacement of activities, since it focuses on a model of land use change in areas dedicated to extensive livestock farming, with very low units of livestock per hectare. The project region is characterized by large areas of plains of native and introduced grasses that are continually burned in order to be renewed, depleting their fertility and promoting soil degradation. It is estimated that the activity does not lead to the generation of escapes, since the region is capable of supporting the possible displaced heads of livestock, if this were the case. Likewise, the project owners are not intervening in all areas of the properties, allowing for livestock

rotation areas as the remaining heads are sold. These livestock are not expected to be replaced in the future in the project areas.

Now, this analysis complies with literal a) of section 15.3 BCR0001, therefore the leaks are considered zero.

16.4   Net GHG Emission Reductions / Removals

Table 18 - General balance of reduced CO₂, when considering all carbon deposits, strata and areas of the project.

stratum	area stratum (ha)	tCO₂ belowground + aboveground biomass(tCO₂)	CSHRUBS shrubs (tCO₂)	Dead wood CDW (tCO₂)	Leaf litter CLI (tCO₂)	COS (tCO₂)	Balance final (tCO2)	n	N Estimated
Low	902,47	4.504	7.646	200	333	9.631	34.844	74	15
Regular	419,27	12.412		551	919			19	17
Total Sink	1.321,7	16.916	7.646	751	1.252	9.631		145	32
Share (%)		44.7%	21.9%	2.2%	3.6%	27.6%	100.0%		

16.4.1.1   Net removals monitoring period.

Buffer the carbon reserves.

According to the risk analysis developed for the project, which shows to be close to 10%, for the final balance a value of 20% of this buffer is assumed, maintaining conservative positions regarding the amount of carbon and carbon credits that could be put on the market. This 20% is also in line with the requirements of the national certifying bodies, with which the registration process will be accepted.

Development of estimates for each verification year.

Although the monitoring analysis period covers the years 2015-2019, it is necessary to establish values of assigned removals for each year. For this, the percentage contribution values were taken in the accumulation curves adjusted for each species with cut-off at the first seven years of planting. This process was performed for each species in the commercial stand model. Then, with these percentage values, the weighted values of annual contribution were found according to the hectares planted for each year and species.

The results for each species according to the planted area are shown in the following table.

Table 19 - Weighted contribution by stand and species model to the carbon balances for the period 2015-2019 of the current monitoring report. These values will be allocated for annual net removals.

Weighted Cto Species and total (%)			
Year	*Pinus caribaea*	*Sum (%)*	Total, weighted development year 2019
2018	25,1%	25.3%	31,7%
2019	42,0%	42.2%	53,0%
	79,2%	79.2%*	84,7%

*This value does not reach 100% of development in the first seven years, since some stands at the 2019 cut have developed less than five years (e.g., 2017 and 2018 plantings). This value is 100% from which the weighted values for each year are derived. Values from years 2015 to 2016 were taking into account for calculations but were not show at the table.

Balance Final.

An anthropogenic net reduction of 29,508 tCO2 eq is estimated. The reserves or reduced emission units that are allocated to the buffer are 5,902 tCO2 eq, which is equivalent to 20% of the total. Finally, a total of 23,607 tCO$_2$ eq is estimated to be traded on markets. It should be noted that the Buffer or reserved units are periodically released and put on the markets.

Table 20 - Final balance of removal emissions for the 2018-2019 monitoring period.

Year	Baseline emissions (tCO$_2$e)	Project removals (tCO$_2$e)	Leakage emissions (tCO$_2$e)	Net GHG removals (tCO$_2$e)	Buffer	Total VCC (tCO$_2$e)
01-01-2018 -- 31-12-2013	0	11,043	0	11,043	2,209	8,834
01-01-2019 -- 31-12-2019	0	18,465	0	18,465	3,693	14,772
Total	0	29,508	0	29,508	5,902	23,607
Average				14,754	2,951	11,803

The *Excel* file of the greenhouse gas removal balances developed by the project can be found in Annex Section 3 - Quantification of GHG emissions reduction/Quantifications/ Ex post/Ex-post 2018 – 2019_v3.xlsx.

16.5 Comparison of actual emission reductions with estimates in the project document

Below is the comparison between the estimated removals and those achieved during the monitoring period, the justification is presented in section 16.6.

Table 21 Comparison of actual removals with estimates in the project document

Year	Net GHG removals (tCO$_2$e) – ex ante	Net GHG removals (tCO2e) – ex post	Percentage difference (%)
2018	15605	11,043	29
2019	35785	19,183	48

16.6 Remarks on difference from estimated value in the registered project document

It can be seen that the removals achieved during the monitoring period were lower than those indicated in the ex-ante estimates, which may be due to the biomass values determined during the monitoring estimates, which were carried out through measurements in field and analysis of remote sensors.

17 Bibliografía

Andrade, H., Segura, D., Canal, M., Gomez, M., Marin, M., & Ramirez, E. (2013). *Estrategias de Adaptación al Cambio Climático en Sistemas de Producción Agrícola y Forestal en el Departamento del Tolima.* Ibague: Universidad del Tolima.

Chaparron Pinzón , M., Corradi, C., García Guerrero, A., Lara Henao, W., Perugini, L., & Ulloa Cubillos, A. (2007). *Sembrando bosques, opciones frente al cambio climático global - Mecanismo de desarrollo limpio - forestal.* Bogotá, Colombia: UNODC-COLOMBIA, MAVDT, Universita Degli Della Tuscia Viterbo, UNAL. Obtenido de https://www.unodc.org/documents/colombia/2013/Agosto/DA2013/2._MDL-FORESTAL.2008.pdf

Cisneros Ramirez, L., & Amezquita Picon, J. (2015). *ESTRATEGIAS DE ADAPTACIÓN Y MITIGACIÓN AL CAMBIO CLIMÁTICO DESARROLLADAS POR COMUNIDADES FORESTALES EN COLOMBIA.* Bogota DC: UNIVERSIDAD DISTRITAL FRANCISCO JOSÉ DE CALDAS FACULTAD DEL MEDIO AMBIENTE Y RECURSOS NATURALES PROYECTO CURRICULAR DE INGENIERÍA FORESTA.

Davidson E. A., D. C. (1995). *Pasture Soils As Carbon Sink.* Nature 376: 472-473.

Fisher, M. J. (1994). *Carbon Storage By Introduced Deep-Rooted Grasses In The South American Savannas.* Nature 371: 236-238. .

Galindo, G., Espejo, O. J., Rubiano, J. C., Vergara, L. K., & Cabrera , E. (2014). *Protocolo de procesamiento digital de imágenes para la cuantificación de la deforestación en Colombia. V 2.0.* Bogotá D.C.: Instituto de Hidrología, Meteorología y Estudios Ambientales – IDEAM. Obtenido de https://redd.unfccc.int/files/anexo_a_protocolo_procesamiento_digital.pdf

IDEAM. (2018). *CAMBIO CLIMÁTICO.* Obtenido de POLÍTICA NACIONAL DE CAMBIO CLIMÁTICO: http://www.cambioclimatico.gov.co/directorio-del-cambio-climatico#:~:text=El%20objetivo%20de%20la%20Política,por%20efectos%20del%20cambio%20climático.

Intergovernmental Panel on Climate Change (IPCC). (2003). *Good practice guidance for land use, land – use change and forestry. Institute for global environmental strategies of IPCC.* Hayama.

Rao, I. G. (2001). *Producción de biomasa vegetal epígea e hipógea en las sabanas nativas.* Centro Internacional de Agricultura Tropical.

Rippstein, G. .., Escobar, E. .., Toledo, J. .., Fisher, M. .., & Mesa, E. .. (2001). *Caracterización de comunidades vegetales de la altillanura en el Centro de Investigación Agropecuaria Carimagua, en Meta, Colombia.*

Trumbore, S. E. (1995). *Belowground cycling of carbon in forests and pastures of Eastern Amazonia.* Global biochemical cycles 9(4): 515-518.