CARBON
CERTIFICAÇÃO
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AMBIENTAIS

TERO.004 – CARBON REMOVAL IN AGRICULTURAL CROPS

VERSION 2.0

METHODOLOGY, AFOLU, CARBON STORED IN CROP

TERO CARBON AVALIAÇÕES E CERTIFICAÇÕES S.A.

IDENTIFICATION

METHODOLOGY	TERO.004 – Carbon Removal in Agricultural Crops
VERSION	2.0
STATUS	Under Public Consultation
PUBLICATION DATE	04/02/2025
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STANDARD	Tero Carbon Avaliações e Certificações S.A. (contato@terocarbon.com)
PROGRAM	Nature-Based Solutions (NBS)
SECTOR	Agriculture, Forestry, and Other Land Uses (AFOLU)
TYPE	Carbon Stored in Crop
ASSET GENERATED	Verified Carbon Credit (tCO_2e)
PROJECT ACTIVITIES	Carbon Removal by Crops
GHG MITIGATION	Removal

LIST OF ACRONYMS

AGB	Above-Ground Biomass
AFOLU	Agriculture, Forestry, and Other Land Uses
APD	Avoided Planned Deforestation
BAU	Business as usual
BGB	Below-Ground Biomass
CS	Carbon Stock
DDW	Down and Dead Wood
GHG	Greenhouse Gas
IBGE	Brazilian Institute of Geography and Statistics, in Portuguese, *Instituto Brasileiro de Geografia e Estatística*
IDHM	Municipal Human Development Index, in Portuguese, *Índice de Desenvolvimento Humano Municipal*
KPI	Key Performance Indicator
LRA	Legal Reserve Area
MRV	Measurement, Reporting, and Verification
MUA	Multiple-Use Area
NBS	Nature-based Solutions
PA	Project Area
PB	Property Boundary
PPA	Permanent Preservation Area
PRODES	Deforestation Monitoring Project in the Legal Amazon by Satellite, in Portuguese, *Projeto de Monitoramento do Desmatamento na Amazônia Legal por Satélite*

LIST OF PROGRAMS

Certification Program
Methodologies Program
Assets Program

LIST OF SUPPORTING DOCUMENTS

NAME	PROGRAM
Definitions	All
Project Additionality Demonstration Tool	All
Project Scale Analysis Tool	All
Socio-Environmental Safeguards Analysis Tool	All
Acceptance Criteria Analysis Tool for Project Verification	All
Land Tenure Compliance Analysis and Certification Tool	NBS
Methodological Basis and Methods for Estimating Carbon Stocks in AFOLU Projects	NBS
Non-Permanence Risk Analysis Tool and Buffer Reserve Calculation	NBS

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1. INTRODUCTION

The growing demand for effective solutions to mitigate climate change has driven the development of strategies based on the removal of greenhouse gases (GHGs) through sustainable production systems. In the AFOLU sector (Agriculture, Forestry, and Other Land Use), agricultural practices that promote carbon sequestration play a key role in the transition to a low-carbon economy.

The **Carbon Removal in Agricultural Crops** methodology, developed under the NBS Program (Nature-Based Solutions), provides technical guidelines for quantifying and verifying carbon stored in crops, resulting from the removal of atmospheric CO_2 through photosynthesis and biomass accumulation. The focus is to ensure that eligible projects can generate Verified Carbon Credits (tCO_2e) with a high level of environmental integrity and transparency, following recognized standards and applying measurable, reportable, and verifiable (MRV) practices.

2. SCOPE, ACCEPTANCE CRITERIA AND ACTIVITIES

2.1. Scope

This methodology is applied to projects in the AFOLU sector that promote carbon sequestration through biomass accumulation in agricultural crops.

2.2. Acceptance Criteria

This methodology applies to projects that meet the following acceptance criteria:

I. **Land Tenure Compliance:** The project must be implemented on rural properties with verified land tenure regularity, as defined by the "**Land Tenure Compliance Analysis and Certification Tool**" The property may be privately or publicly owned;

II. **Territorial Configuration:** The project area may be contiguous or consist of multiple land parcels, provided it forms an ecological mosaic that ensures biome connectivity and integrity;

III. **Active crop area:** The project area must be designated for continuous agricultural production;

IV. **Project Area Location and Additionality:** The Project Area (PA) must be within the boundaries of the consolidated property area, that is, outside Permanent Preservation Areas (PPAs) and Legal Reserves (LRs). Additionally, the activities must not result from legal requirements, court orders, or formal commitments, such as TACs or mandatory environmental compensations;

V. **Additional Socio-Environmental Impacts:** Beyond direct carbon removal, the project must demonstrate, through clear indicators, the occurrence of at least two additional socio-environmental benefits;

VI. **Compliance with Socio-Environmental Safeguards:** The project must fully adhere to the socio-environmental safeguards established by the "**Socio-Environmental Safeguards Analysis Tool**"; and

VII. **Clear Identification of Key Roles:** The project must explicitly identify the key stakeholders responsible for its implementation. It is mandatory to designate at least one Primary Proponent, one Developer, one Generator, and one Implementer. Each role must be clearly defined, detailing the respective responsibilities and contributions to the project's execution.

2.3. Activities

This methodology provides for the generation of carbon credits (removal) through the following activities:

I. **Carbon Removal by Crops:** This activity involves the cultivation of agricultural crops, such as coffee or others, under proper management that enhances carbon removal from the atmosphere through photosynthesis. Sustainable farming practices are employed to optimize carbon capture and storage, contributing to climate change mitigation by promoting soil health and increasing biomass.

3. BASELINE

3.1. Selection of Project Activity Implementation Areas

The project activity implementation area, referred to as the Project Area (PA), must be geographically identified (**Figure 1**), along with the main geographic polygons of the rural property: Hydrography, Property Boundary (PB), Permanent Preservation Area (PPA), Multiple-Use Area (MUA), and Legal Reserve Area (LRA).

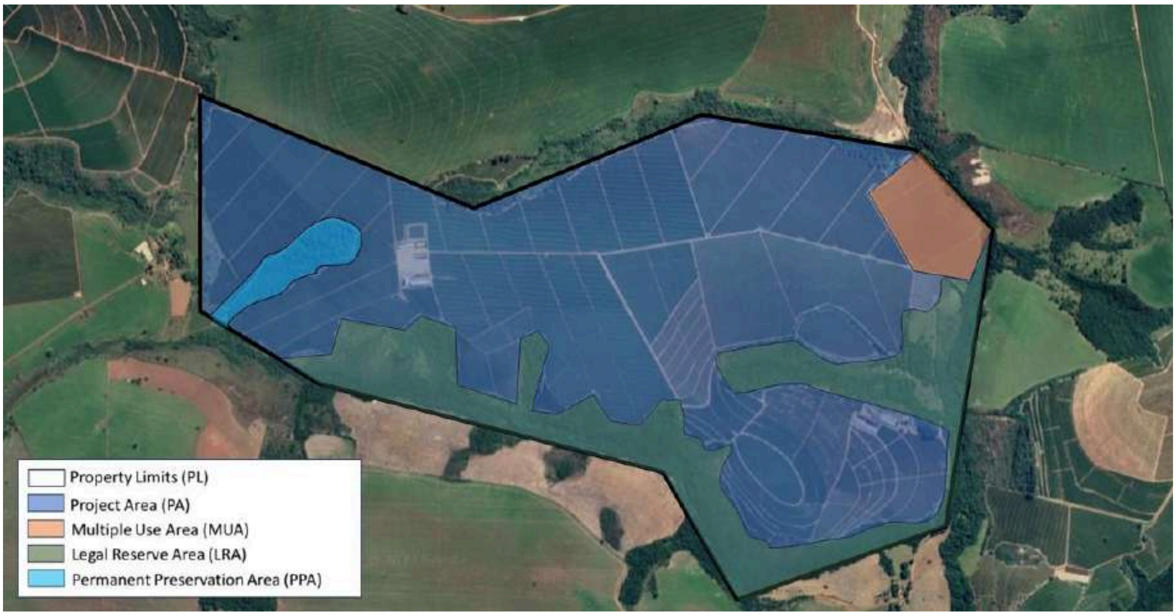

Figure 1. Map identifying the main geographic polygons of the project: Hydrography, Property Boundary (PB), Project Area (PA), Permanent Preservation Area (PPA), Multiple-Use Area (MUA), and Legal Reserve Area (LRA).

3.2. Selection of Carbon Pools Used in Carbon Stock Accounting

The project must specify which carbon pools were considered in the accounting of carbon stocks. **Table 1** presents the types of carbon pools accepted by this methodology.

Table 1. Types of carbon pools accepted by the methodology.

POOL	ACRONYM	MANDATORY
Above-Ground Biomass	AGB	Yes

POOL	ACRONYM	MANDATORY
Below-Ground Biomass	BGB	Yes
Litter	Litter	No
Dead wood and soil organic carbon	DDW	No

The emission sources and greenhouse gases (GHG) considered in the accounting of carbon removal by crops are described in **Table 2**.

Table 2. Emission sources and GHG considered in the accounting of carbon removal by crops activity.

STAGE	SOURCE	GAS	USED	JUSTIFICATION
Pre-project (BAU)	Emissions from the use of nitrogen fertilizers	CO_2	No	Conservatively excluded due to MRV tool limitations.
		CH_4	No	
		N_2O	No	
	Fossil fuel combustion	CO_2	No	
		CH_4	No	
		N_2O	No	
Project Implementation	Biomass burning	CO_2	Yes	If the project includes the burning of woody biomass as part of cultural practices for planting and harvesting, the resulting emissions must be accounted for.
		CH_4	No	Conservatively excluded due to MRV tool limitations.
		N_2O	No	Conservatively excluded due to MRV tool limitations.

STAGE	SOURCE	GAS	USED	JUSTIFICATION
Project Implementation	Emissões Emissions from nitrogen fertilizer use	CO_2	No	Conservatively excluded due to MRV tool limitations.
		CH_4	No	Conservatively excluded due to MRV tool limitations.
		N_2O	Yes	Can represent a significant emission and should therefore be accounted for.
	Fossil fuel combustion	CO_2	Yes	If harvesting products from the crops involves the use of vehicles and machinery, the emissions generated by these operations must be accounted for.
		CH_4	No	Conservatively excluded due to MRV tool limitations.
		N_2O	No	Conservatively excluded due to MRV tool limitations.

3.3. Selection of the Baseline and Demonstration of Additionality

This methodology bases its additionality on the ability of agricultural cultivation – exemplified by coffee – to promote the removal of greenhouse gases (GHG) and carbon accumulation, while driving socio-economic development in regions strategic for Brazilian agribusiness. For example, coffee cultivation in the Cerrado of Minas Gerais illustrates the balance between agricultural production and environmental conservation, contributing to economic growth and job creation in rural areas. The Cerrado, recognized as one of the most biodiverse savannas in the world, has been an important agricultural frontier since the 1970s (IBGE, 2018).

Moreover, agriculture not only ensures food supply and nutritional security, but also generates employment opportunities and strengthens the resilience of local communities. Municipalities with structured production chains, such as

Patrocínio (MG), show more favorable socio-economic indicators compared to less active regions in the agricultural sector. For example, official data (IBGE) indicates that the Municipal Human Development Index (IDHM) of Patrocínio is significantly higher than that of municipalities with lower agricultural activity, such as areas in the interior of Amazonas, showing lower economic vulnerability in these areas.

Additionally, sustainable agricultural practices contribute to mitigating illegal deforestation. Recent information from PRODES shows that municipalities with established production chains report lower deforestation rates compared to areas with less agricultural structure. The use of techniques that favor carbon removal and soil conservation reduces the pressure to open new areas, contributing to the preservation of local ecosystems.

Thus, the additionality of projects applying this methodology goes beyond carbon sequestration, encompassing socio-economic, environmental, and food security benefits. Without the implementation of these projects, not only would the emissions removed fail to occur, but local communities would lose essential opportunities for sustainable development, and natural areas would become more susceptible to unsustainable practices and illegal deforestation.

To demonstrate additionality, the developer should use the "**Project Additionality Demonstration Tool**" available in the Certification Program.

3.4. Baseline for Emissions Removed through Natural Restoration

To account for the natural restoration of vegetation on the property or for maintaining the degraded state, the calculation of greenhouse gas (GHG) emissions removed in the project baseline should consider the scenario where the project is not implemented, reflecting the natural or stagnant dynamics of carbon stock over time.

The baseline should be constructed from the initial carbon stock (CS_0) present in the target area and projections based on its potential evolution (or lack of evolution) in the long term, considering environmental, historical, and socio-economic factors that influence land use.

The developer must present technical evidence supporting the adopted model, which may include historical satellite imagery and local data to demonstrate whether the area has the potential for natural regeneration or will remain in a degraded state without direct intervention. This reference scenario is essential for the accurate quantification of the project's climate benefits, ensuring the credibility and precision of the carbon credits generated through the effective removal of GHGs. Equation (1) shows how the baseline should be presented.

$$CS(t)_{BSL-NAT} = \left(CS_0 + fCS(t)_{NAT}\right) \pm IC \quad (1)$$

where:

$CS(t)_{BSL-NAT}$	=	baseline carbon removed at time "t" (in tCO2e) from the natural restoration of vegetation (NAT) within the project area boundaries;
CS_0	=	carbon stock at the start of the project (in tCO2e);
$fCS(t)_{NAT}$	=	function representing the natural variation of carbon stock over time – either through natural restoration or the maintenance of the degraded state (in tCO2e); and
IC	=	Confidence Interval (in tCO2e).

3.5. Leakage

The calculation of leakage is considered optional in this methodology, as there are no proven means for its verification, nor effective management mechanisms for surrounding areas of the project. However, nothing prevents the proponent from presenting their own approach, including a specific methodology and criteria for quantifying leakage, should they wish to demonstrate the possible indirect impacts arising from the implementation of the project activities. If applicable, leakage is given by equation (2):

$$LK(t) = LK(t)_{PROJ} \quad (2)$$

where:

$LK(t)$	=	emissions due to leakage at time "t" (in tCO2e); and
$LK(t)_{PROJ}$	=	project leakage, when presented, at time "t" (in tCO2e).

3.6. Quantification of the Current Carbon Stock in the Project Area

The quantification of the current carbon stock in the project area (CS_{ACTUAL}) must be presented with a known confidence interval (IC), ensuring the accuracy and robustness of the calculation. This methodology recommends using the document "**Methodological Basis and Methods for Estimating Carbon Stocks in AFOLU Projects**" as a technical reference, providing standardized guidelines for estimating carbon stocks in AFOLU sector projects. However, each developer is free to present their own quantification method, as long as they clearly explain the approach used and the correction factors applied to the site, ensuring transparency and consistency in the results.

3.7. Calculation of the Net GHG Removals by the Project

The net GHG removals by the project are obtained by the difference between baseline emissions and current emissions from the project, deducting any fugitive emissions (leakage). Equation 3 describes the calculation method, covering the emissions and removals associated with agricultural cultivation activities:

$$C(t)_{TOT} = \left(CS(t)_{ACTUAL} - CS(t)_{BSL-NAT} - Ef(t) - LK(t)\right) \pm IC \quad (3)$$

where:

- $C(t)_{TOT}$ = Total net emissions from the carbon removal project in agricultural crops at time "t" (in tCO2e);
- $C(t)_{TOT\text{-}NAT}$ = Total net emissions from the natural restoration activity of the rural property (NAT) at time "t" (in tCO2e);
- $CS(t)_{ACTUAL}$ = Current liquid carbon stock in the project area (PA) at time "t" (in tCO2e);
- $Ef(t)$ = Increase in GHG emissions (fugitive emissions) at time "t" (in tCO2e) within the project area due to planting and crop maintenance activities (such as fertilization);
- $LK(t)$ = GHG emissions due to leakage at time "t" (in tCO2e); and
- IC = Confidence Interval (in tCO2e).

3.8. Risk of Non-Permanence and Buffer Reserve Calculation

Non-permanence risk (*Rnp*), also known as the reversal risk, refers to the possibility of partial or total loss of carbon stocks obtained by the project over time. This methodology allows the developer to present their own approach and calculation method to estimate the non-permanence risk, as long as it is clear, transparent, and properly justified.

The project must adopt safeguards to minimize non-permanence risks (*Rnp*), adjusting their approach according to the activity being developed. For carbon removal projects through crops, a portion of the credits generated should be allocated to a buffer reserve (α), calculated based on a non-permanence risk analysis.

As support, the document "**Non-Permanence Risk Analysis Tool and Project Buffer Reserve Calculation**" provides different approaches for adopting the safeguard.

3.9. Calculation of Generated Permanent Carbon Credits

The calculation of permanent carbon credits (*pC*) follows the buffer reserve approach, where a fraction (α) of the credits becomes permanent at each verification. The project must ensure that no reversal results in the generation of negative credits and that there is no double counting of carbon removal already accounted for.

The amount of permanent credits generated in verification period "n" is given by the difference between the net total emissions removed in the current verification ($C_{TOT\ n}$) and the maximum net total emissions previously recorded in the project ($C_{TOT\ max}$), discounting the buffer reserve. Equation (4) presents the calculation:

$$pC_n = \left(C_{TOT\ n} - C_{TOT\ max}\right) \times \alpha \tag{4}$$

where:

pC_n	=	Permanent carbon credits generated in verification period "n" (in tCO_2e);
$C_{TOT\ n}$	=	Net total GHG emissions removed by the project in the current verification (n) (in tCO_2e));
$C_{TOT\ max}$	=	Highest C_{TOT} value ever recorded in the Project Area up to the current verification (in tCO_2e); and

α = Fraction of credits that become permanent.

Rules to Prevent Negative Credits and Double Counting:

- If a reversal occurs (i.e., if $C_{TOT\,n} < C_{TOT\,max}$), then $pC = 0$;
- The highest C_{TOT} previously recorded in the project ($C_{TOT\,max}$) must be used as a reference to avoid double counting of carbon removals; and
- The buffer reserve is applied to all net removals, ensuring security against future risks.

3.10. Definition of the Project Scale

The project scale must be defined based on the potential for annual carbon credit generation. To support this analysis, the Certification Program provides the "**Project Scale Analysis Tool**," which guides the developer in presenting the proposed scale, considering estimates of emissions removed. However, it is the responsibility of the developer to justify the defined scale, based on technical parameters and realistic projections, ensuring the coherence between the project's capacity and its GHG mitigation potential.

4. MONITORING PROCEDURE

4.1. Monitoring Plan

The monitoring plan is crucial to ensure the quality, traceability, and environmental integrity of the project's results over time. The monitoring should cover continuous verification of essential aspects, including:

I. The continuous validity of the acceptance criteria defined for the project;

II. The updated quantification of carbon stocks within the project area;

III. The assessment of co-benefits selected through key performance indicators (KPIs));

IV. Monitoring and mitigation of non-permanence risks; and

V. when applicable, monitoring of potential leakage.

4.2. Methodology and Quality of Monitoring

As part of the monitoring procedure, the project developer must establish a clear and replicable methodology for data collection, analysis, and reporting, ensuring that the processes are auditable and consistent throughout the verification cycles. The plan must describe the tools, technologies, and frequencies used for monitoring, as well as identify the responsibilities of the parties involved. The developer must also adopt measures to ensure data quality, including internal audits, control procedures, and detailed records of all monitored activities.

4.3. Period Between Verifications

The period between verifications must be defined by the developer in the Monitoring Plan, considering the nature of the project and the frequency required to ensure the quality and traceability of the results. However, this interval should not exceed three years to ensure that the collected data remains updated and consistent with the project's reality. Ideally, verifications should be conducted annually, allowing for continuous monitoring of the project's performance, quick identification of deviations, and implementation of corrective actions when necessary.

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4.4. Monitoring Report

At each monitoring period, when requesting a verification, the project developer must submit a comprehensive Monitoring Report. This report should present the quantified results of net emissions, clearly indicating the carbon credits required for the current crediting period. In addition to the written document, the developer must also provide spreadsheets and supporting information available in the "**Acceptance Criteria Analysis Tool for Project Verification**" This documentation ensures that all data and calculations are transparent, auditable, and consistent with the project's monitoring and verification requirements.

VERSION HISTORY

VERSION	DATE	NOTES
2.0	04/02/2025	Version with substantial updates to the methodology structure, including the name change and update to the baseline calculation.
1.0	01/30/2024	Initial version approved by the Board and released for public consultation.