

'EL ARRIERO' AFFORESTATION ON DEGRADED GRASSLANDS UNDER EXTENSIVE GRAZING MONITORING REPORT



Document Prepared By Carbosur Ltda.

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1 PROJECT DETAILS

1.1 Summary Description of Project

The project comprises a total of 4,987.91 ha of land previously under extensive grazing by beef cattle, on which afforestation for obtaining high-value, long-lived timber products and for sequestering large amounts of carbon dioxide from the atmosphere was established.

Forests are based on 22-25 year rotation Loblolly Pine (*Pinus taeda*) and Hybrid Pine (caribea x elliotti) plantations, managed with pruning (to a height of 5.6 m) and two thinning operations, to obtain knot-free, high-diameter logs suitable for saw-milling. Plantation were completed by year 2 of project and forests will be replanted after clear-cut harvest. Practices are certified with FSC standard¹. The baseline study determined that continuation of extensive grazing is the most likely use of the land. Additionality is demonstrated through the fact that the expected internal rate of return of the proposed project activity without considering carbon finance is lower than the benchmark internal rate of return for this type of investment in Uruguay. In addition, barriers analysis and common practice analysis showed that afforestation in the area of the proposed project activity is not likely to occur without carbon financing.

Planted forests removed carbon dioxide from the atmosphere and stored it in different carbon pools (living above-ground and below-ground biomass, soil, litter and dead wood). In this first monitoring event the carbon stock in different pools is measured and compared to zero. The results are presented in this Monitoring Report.

1.2 Sectoral Scope and Project Type

The activity implemented by the project participant consist in the establishment of forests on land that had previously been under grassland for more than 30 years (methodology requirement), and therefore corresponds to the VCS scope 14: "Agriculture, Forestry and Other Land Use" as an Afforestation, Reforestation and Revegetation (ARR).

The project is not a grouped project.

1.3 Project Proponent

Project proponent is Forestal 'El Arriero S.A.'. The Company is legally constituted for investment in Uruguay. Contacts details are the following:

Contact person: Alberto Voulminot

Street: Dr. Luis A. de Herrera 1248 Torre B Piso 17

City: Montevideo

Zip code: 11.300.

Country: Uruguay

Phone: +598 2 628 5029

1.4 Other Entities Involved in the Project

Forestal 'El Arriero S.A.' has a contractual agreement with Cambium Forestal Uruguay S.A. for the management of its investments. Cambium Forestal Uruguay S.A. is internally well structured, with experienced staff in the area of forest investments and forest management. The internal organization chart and other relevant information was checked during validation.

Contact information:

Address: General Paz 1516

¹ See FSC certificate at: <http://info.fsc.org/details.php?id=a0240000005sSGJAA2&type=certificate&return=certificate.php>

City: Montevideo
Zip code: 11.400
Country: Uruguay
Phone: +598 2601 0662
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Carbosur Ltda. is the consultant in charge of the development of the carbon component of the project.

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The field measurements were conducted by an outsourced-third party: Pike Consultora Forestal. The company was hired to provide this specific service for El Arriero. Technicians of Pike Consultora Forestal will form part of the technical group attending the on-site visit during verification.

Contact Person: Álvaro Pérez del Castillo
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www.pikeconsultora.com.uy



1.5 Project Start Date

The project start date is 30 April 2009, when the activities that lead to the generation of GHG emission removals (preparing land for planting) were first implemented. The project start date was also checked during validation.

1.6 Project Crediting Period

Forestal 'El Arriero S.A.' project crediting period is comprised between April 30th 2009 and April 30th 2109; resulting in 100 years.

1.7 Project Location

The project area is located in East Uruguay, in Cerro Largo and Treinta y Tres departments. It comprises several sites, which are classified in 4 regions based on geographic location. The areas are homogeneous in terms of soil types, climate, land use history and socio-economic conditions. The map in Figures 1 and 2 shows the exact location of the project, as well as the cadastral units owned by Forestal 'El Arriero S.A.', and figures 3 to 6 shows the 4-region project area division mentioned above.

Project area was stratified in order to homogenize the population and achieve more accurate results in the variables measured. The preliminary stratification was done prior to the implementation of the measurements and was established in the Monitoring Plan of the Project Design. The strata were defined with three main variables: tree species, plantation date and region.

Nevertheless, the actual and post-stratification number of strata can vary. Project strata can be constantly re-defined after plantation if disturbance events take place. In this first monitoring event the strata was maintained as defined in the Project Description.

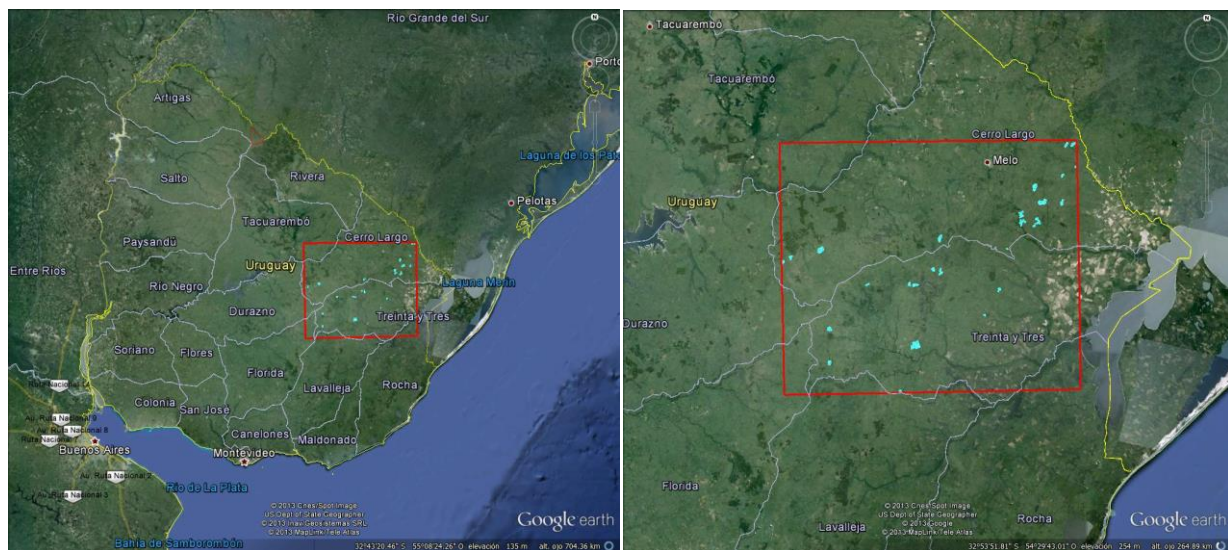


Figure 1. Satellite image of Forestal 'El Arriero S.A.' project boundaries.

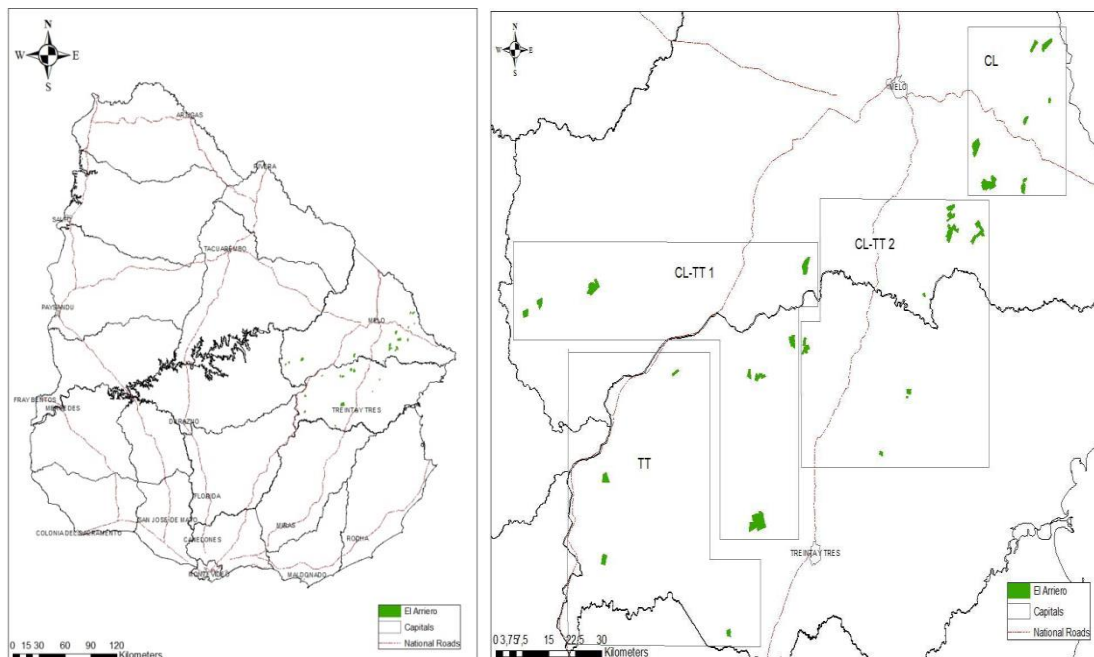


Figure 2. Maps indicating the four project regions.

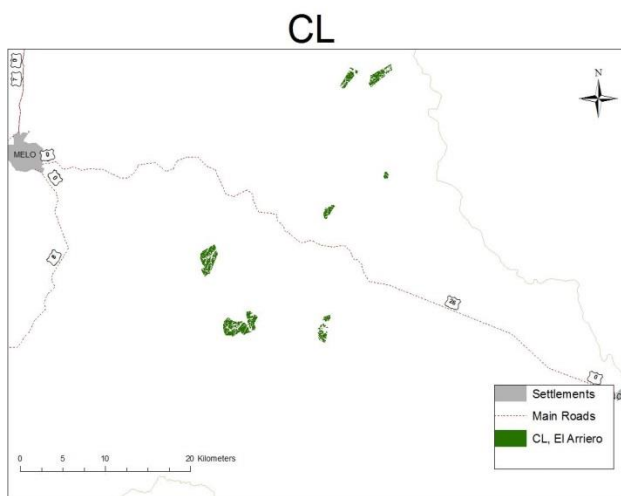


Figure 3. Location of Forestal 'El Arriero S.A.' project boundaries, which forms the region CL (Cerro Largo).

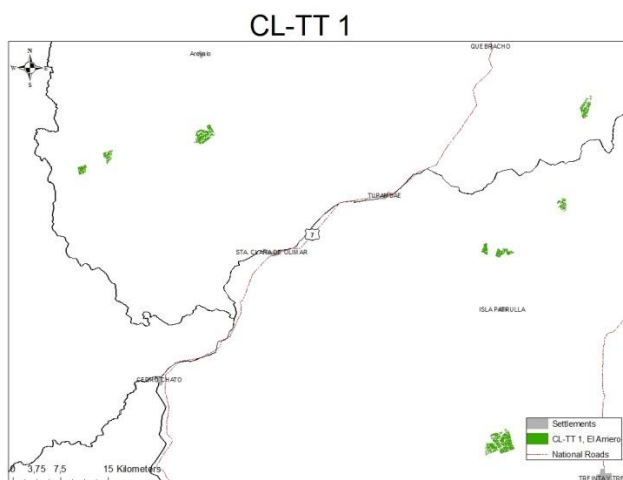


Figure 4. Location of Forestal 'El Arriero S.A.' project boundaries, which forms the region CL-TT1 (Cerro Largo-Treinta y Tres).

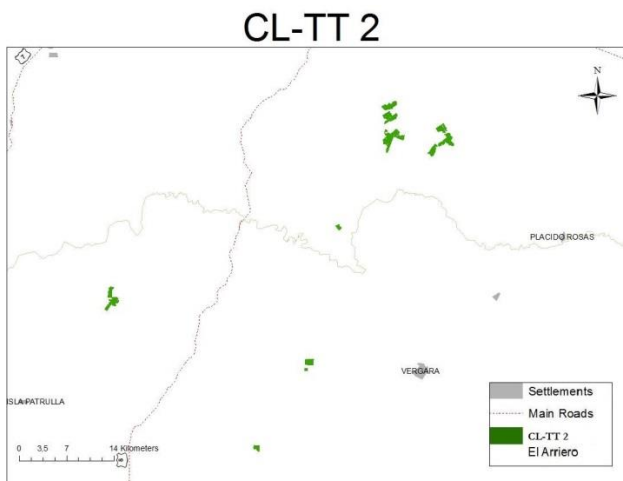


Figure 5. Location of Forestal 'El Arriero S.A.' project boundaries, which forms the region CL-TT2.

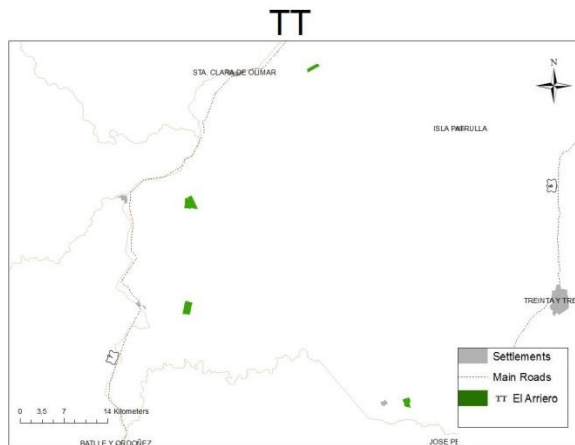


Figure 6. Location of properties belonging to Forestal 'El Arriero S.A.', which forms the region TT (Treinta y Tres).

All properties of 'El Arriero S.A' are legally owned and are covered by deeds duly registered with the National Records, registered with the corresponding number for the Registration of Real Estate. There

are no conflicts related to tenure or use rights over the land affected by the project or its products as demonstrated during validation.

Project boundaries have been identified using a GPS and aerial photographs, and have been laid on a geographic information system. No visible landmarks have been established on the field. Maps with exact project boundaries and its coordinates will be available for the verification team.

1.8 Title and Reference of Methodology

The consolidated CDM methodology AR-ACM0001 "Afforestation and reforestation of degraded land" (version 05.2.0, EB 65) was applied:

<http://cdm.unfccc.int/methodologies/DB/X4VOLW3Y7IJCH9WXSXBC2Q0JKG9UZ>

The following methodological tools, to which the selected methodology refers to, were used:

Version 01 of "Combined tool to identify the baseline scenario and demonstrate the additionality in A/R CDM project activities";

Version 01 of "Tool for testing significance of GHG emissions in A/R CDM project activities";

Version 04.0.0 of "Estimation of non-CO2 GHG emissions from burning of biomass attributable to a A/R CDM project activity"

Version 01 of "Tool for the identification of degraded or degrading lands for consideration in implementing CDM A/R project activities";

Version 02.0.0 of "Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activity".

Version 03.0.0 of "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activity".

Version 01 of "Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity";

Version 01.1.0 of "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities".

Forestal 'El Arriero S.A.' Project Document was validated and ultimately registered under the VCS on the 18th January 2013. At that moment the methodology "AR-ACM0001 Afforestation and Reforestation on degraded land" (V 5.2.0, EB 65) was still valid to be used in Afforestation and Reforestation CDM (or VCS) projects. According to the CDM, the request for registration of any project using the mentioned methodology could be submitted until the day in which 'El Arriero' was registered. After that date the methodology was substituted with the Combined Methodology: "AR-ACM0003: Afforestation and reforestation of lands except wetlands". However, for the purpose of this project Monitoring Reports and subsequent monitoring reports, the methodology to be applied correspond to AR-ACM0001.

2 IMPLEMENTATION STATUS

2.1 Implementation Status of the Project Activity

Forestal 'El Arriero S.A.' first areas were planted in 2009 and the last ones in 2011. The project has recently completed its third year. The forests had already had one thinning operation in year 2012 on those forests which had been planted in 2009.

As has been stated in PD, the methodology identifies activity displacement as the only potential source of leakage (conversion from grazing land to forestry). As it was demonstrated during validation, the project implementation does not and did not cause any displacement of activities. The only activity in the project area prior to the start date is extensive grazing by beef cattle, which continues to occur after project start. This can be audited by the verification team during on site visit. It was also stated and validated in the PD that there was no need for a leakage management plan neither for leakage mitigation options.

The information related to the non-permanence risks of the project is presented in a separate document called "Non Permanence Risk Report".

2.2 Project Description Deviations

The forest area of the project slightly changed from 5,377.0 to 4,987.91 hectares. The difference is explained by the continuous upgrade of the project Geographical Information System, which resulted in the detection of some minor modifications. The reduction in the forest area was analyzed and it is due to minor corrections in the Geographical Information System, thus the new total area is presented in this verification with a detailed explanation of the modification, but the project boundaries will always be the same. The reduction in the forest area does not represents a reversal (according to the VCS document Program Definitions) or a catastrophic event, then the project participant did not communicate this to the VCS and monitored the loss. None of these situations have occurred within Forteko's project boundaries.

The principal modification is the area under San Fermín farm, which resulted in a decrease in the total area. There was no physical boundary modification for this case, the explanation is that there was an error while processing the shapefile, it was not refreshed after some modifications when presented for validation and the value shown was an old number considering other extra-boundaries polygons.

The second largest modification is the area reported under Sandobayú farm. During this verification event it was discovered that 7 polygons (83.94 ha, 21.8% difference) included in Arriero project were planted on previous forestland, meaning that the area cannot be classified as "afforestation", thus they have to be deleted from the total area under this carbon sequestration project. The image below shows Sandobayu farm with different polygons in different colors: yellow polygons are the net planted area included in the project, green and red polygons were subtracted for this verification. The blue polygon is *Eucalyptus grandis* plantation wrongly included in the project area for validation and discarded during this verification.

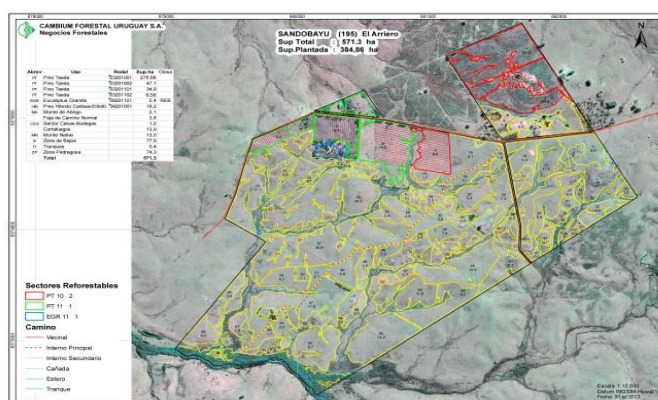


Figure 7. Sandobayu farm².

The rest of the farms comprising Forestal 'El Arriero S.A.' shows a difference in areas between validation and verification of less than 1.2 percent and is presented in the following table with the final forested area of 'El Arriero S.A.' categorized by farm and strata.

Table 1. Forestal 'El Arriero S.A.' area categorized by farm and strata.

Farm	Area at validation	Area at verification	Difference
Altiro	87.1	87.16	0.06
Caburga Lake	92.5	92.48	-0.02
CAT	124.7	123.32	-1.38
Depardieu	102.5	102.40	-0.1
Dionisio Diaz	39.7	39.79	0.09
Eepetaculá	200.3	200.25	-0.05
El Betty	50.9	51.1	0.2
El Enloqucido	100.3	100.38	0.08
El Germano	471.6	493.45	21.85
El Pedregoso	329.7	329.82	0.12
El Sarandí	128.0	127.97	-0.03
El Terco	33.3	33.15	-0.15
La Calera	218.9	218.89	-0.01
La Guadalupe	128.5	128.63	0.13
La Sierra	164.5	164.54	0.04
Las Víboras	258.8	258.78	-0.02
Los Martines	188.6	189.59	-0.99
Obdulio	129.1	129.16	0.06

² Translation and explanations of Spanish words used in the image, from the top and left to the bottom and right: “Cambium Forestal Uruguay S.A. Negocios Forestales” is the administrator of Arriero’s famrs (explained in chapter 1.4 in this monitoring report); “Sup total”=Area total; “Sup. Plantada”=planted area; “Abrev”= abbreviations; “Uso”= Use; “Rodal”= represents the merge of the same species and plantation time; “PT=Pino taeda”= *Pinus taeda*; “Monte de abrigo”=shelter forest; “faja de camino normal”=regular path belt; “sector casas-bodegas”=houses-cellar sector; “Cortafuegos”=firewall; “monte nativo”=native forest; “zona de bajos”=lowlands; “tranqueras”=farm gates; “zona pedregosa”=rocky area.

Picoroco	172.3	170.20	-2.1
Pisoteado	151.9	151.89	-0.01
Pochotito	120.2	120.11	-0.09
Reloco	64.2	64.13	-0.07
Rita Rita	22.9	22.97	0.07
San Fermín	1,132.0	802.16	-329.84
Sandobayú	384.4	300.46	-83.94
Tres Cuartos	307.5	306.97	-0.53
Tres Panes	84.4	84.33	-0.07
Vamoarriba	94.7	94.74	0.04
Total general	5,377	4,987.91	-389.09 ³

Stratum	Area at validation	Area at verification	Difference
A1	55	54.37	-0.63
A2	1,272	1,208.15	-63.85
A3	46	133.05	87.05
A4	23	23.57	0.57
A5	34	33.64	-0.36
A6	1,684	1,352.65	331.35
A7	592	544.6	-47.40
A8	37	6.58	-30.42
A9	30	31.56	-1.56
A10	303	302.47	-0.53
A11	790	786.17	-3.83
A12	29	28.9	-0.10
A13	152	151.98	-0.02
A14	330	330.22	-0.22
Total	5,377.0	4,987.91	-389.09 ⁴

Another project deviation is the number of sample plots which were recalculated after validation. According to the calculations done with the monitoring tool during validation, some strata will have only one measuring plot. However, during verification the project proponent realized that this would cause a statistical problem. After the first series of plots were measured a statistical analysis was conducted to determine the level of error and resulted that a minimum of two samples plots per stratum must be measured. This meant that one extra plot was measured after the initial set of plots (as per the PD) were measured.

³ The value 389.09(ha) is obtained from the difference between 5,377ha and 4,987.91. The sum of the 4th column "Difference" does not lead to the same result because of numbers being rounded.

⁴ The value 389.09(ha) is obtained from the difference between 5,377ha and 4,987.91. The sum of the 4th column "Difference" does not lead to the same result because of numbers being rounded.

Another deviation refers to the different tools listed in the PD. The registered Project Design cited eleven methodological tools which do not exactly corresponds to the methodological tools stated in the methodology AR-ACM0001 at the moment of registration. Despite it is not a Project Description deviations which could affect substantial concepts, it is presented the list of tools registered with 'El Arriero' Project Document and the list of tools that should have been registered with.

Table 2. Summary of used methodological tools and changes observed.

Methodological tool registered with Forestal El Arriero	Comments
Version 01 of "Procedures to demonstrate the eligibility of lands for afforestation and reforestation CDM project activities";	The tool is not used the last version of the methodology (V 5.2.0), however, it is used to demonstrate the eligibility of lands in El Arriero project.
Version 01 of "Combined tool to identify the baseline scenario and demonstrate the additionality in A/R CDM project activities";	Correct, the tool used in the PD corresponds to the list of tools cited by the Methodology AR ACM 0001 at the moment of El Arriero registration.
Version 01 of "Tool for the identification of degraded or degrading lands for consideration in implementing CDM A/R project activities";	Correct, the tool used in the PD corresponds to the list of tools cited by the Methodology AR ACM 0001 at the moment of El Arriero registration.
Version 03.1 of "Estimation of non-CO ₂ GHG emissions from burning of biomass attributable to a CDM A/R project activity";	Correct, the tool used in the PD corresponds to the list of tools cited by the Methodology AR ACM 0001 at the moment of El Arriero registration.
Version 01 of "Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity";	Correct, the tool used in the PD corresponds to the list of tools cited by the Methodology AR ACM 0001 at the moment of El Arriero registration.
Version 01.1 of "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities";	Correct, the tool used in the PD corresponds to the list of tools cited by the Methodology AR ACM 0001 at the moment of El Arriero registration.
Version 02.1.0 of "Calculation of the number of sample plots for measurements within A/R CDM project activities";	The tool is not used the last version of the methodology (V 5.2.0), however, it is used to calculate the number of sample plots for measurements of carbon in El Arriero project.
Version 01 of "Guidance on application of the definition of the project boundary to A/R CDM project activities".	The tool is not used the last version of the methodology (V 5.2.0), however, it is used as a guidance of the definition of the project boundary in El Arriero project
Version 01 of "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activity"	Correct, the tool used in the PD corresponds to the list of tools cited by the Methodology AR ACM 0001 at the moment of El Arriero registration.
Version 01 of "Estimation of carbon stocks and change in carbon stocks in deadwood and litter in A/R CDM project activity"	Correct, the tool used in the PD corresponds to the list of tools cited by the Methodology AR ACM 0001 at the moment of El Arriero registration.
Version 02 of "Guidance on conservative choice and application of default data in estimation of the net anthropogenic GHG removals by sinks"	Correct. This tool is cited in version 5.2.0 of the methodology.

There are also deviations applicable to litter dead wood and soil organic carbon pools. The project developer decided not to measure litter and dead wood pools and to follow the tool "Estimation of carbon

stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities” that offers the possibility not to measure the corresponding variables. For the estimation of carbon stock in litter and dead wood a conservative default-factor based model was applied, and two factors were used: conservative default factor expressing carbon stock in dead wood as a percentage of carbon stock in tree biomass (8%) and default factor for the relationship between carbon stock in litter and carbon stock in living trees (4%). Soil organic carbon is not a measurable variable, the stock and net change in SOC is calculated *ex-ante* and *ex-post* with the use of the “Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities”. However, there were some procedural changes and the total stock in this verification considered the carbon loss attributable to the site preparation.

The total carbon stock calculation in this verification event resulted in lower value than the expected in *ex-ante* estimations. The main reason is the difference between the Mean Annual Increment values assumed in the *ex-ante* estimation in comparison to the Mean Annual Increment measured. The *ex-ante* estimation considered a lineal increment in volume per hectare when in reality the increment draws a sigmoid curve. Also, the difference is explained with the anticipation of the first thinning to the second year after plantation. The population density decreased from 1,000 trees per hectare to 600 as it was planned but instead of doing the first thinning at the fifth year it was done at the second.

Finally, regarding QA/QC procedures, in the PD it was stated that during field work, double check 10% of sampling measurements with an independent party team or with a team different from the one that performed the measurement or sampling would be done. If the difference between measurements was higher than 5%, a third definitive measurement would be run. If the difference was higher than 10%, the data or the plot would be eliminated from the Carbon stock estimations. This does not exactly describe what was done during carbon stocks estimations: in those cases where the differences were higher than 10%, the measurement with a lower result was used in the calculation.

2.3 Grouped Project

Forestal ‘El Arriero S.A.’ afforestation on degraded grasslands under extensive grazing is a single GHG Project.

3 DATA AND PARAMETERS

3.1 Data and Parameters Available at Validation

Table 3. Data and parameters available at validation.

Parameter:	A_i
Data unit:	ha
Description:	Area of stratum i
Source of data:	Monitoring of strata and stand boundaries is done using a Geographical Information System (GIS) which allows for integrating data from different sources (including GPS coordinates and Remote Sensing data)
Value applied:	Variable according to stratum
Purpose of the data:	Project emissions calculation
Any comment:	GPS is the most important tool used for measuring geographical variables or parameters: project boundaries and predefined stratum boundaries,

	forest area, area of disturbances (fires, droughts, harvesting, etc.). All information collected will be immediately integrated to the GIS. Each plot coordinates are charged on the GPS before the field visit in order to reach the exact location of each sample plot. The operator selected on the GPS the following steps: "Destiny > Waypoints". The waypoint of interest is selected by pressing "Go". The operator generates tracks when moving towards each plot, that information is also recorded by the GPS and includes data of waypoints, time, location and altitude on each point of the route. This information is available for the verification team. Exact procedures to locate plots on field are described in the Terms of Reference described in chapter 3.3 Monitoring Plan.
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Parameter:	$BEF_{2,j}$
Data unit:	Dimensionless
Description:	Biomass expansion factor for conversion of stem biomass to above-ground biomass for tree species or group of species j
Source of data:	IPCC default values (e.g. Table 3 A.1.10 of IPCC GPG-LULUCF 2003)
Value applied:	From 1.15 to 3.4, depending on the tree age
Purpose of the data:	Estimation of aboveground biomass carbon content
Any comment:	N/A

Parameter:	CF_j
Data unit:	$t\ C\ t^{-1}\ d.m.$
Description:	Carbon fraction of tree biomass for species or group of species j
Source of data:	The IPCC default value of $0.5\ t\ C\ t^{-1}\ d.m.$
Value applied:	0.5

Purpose of the data:	N/A
Any comment:	N/A

Parameter:	D_j
Data unit:	t d.m. m^{-3}
Description:	Basic wood density for species or group of species j
Source of data:	IPCC 2003, Table 3 A.1.9-1 Basic wood densities of stem wood
Value applied:	0.44
Purpose of the data:	Value used to estimate aboveground biomass content
Any comment:	N/A

Parameter:	R_j
Data unit:	Dimensionless
Description:	Root-shoot ratio for species or group of species j
Source of data:	Tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs"
Value applied:	0.27 to 0.37 depending on an equation which used the aboveground biomass as an input (specific values are presented in the ex-post carbon estimations)
Purpose of the data:	N/A
Any comment:	The equation used to obtain R is in chapter 4.2 of this Monitoring Report

Parameter:	$V_{TREE\ j\ p\ i}$
Data unit:	m^3

Description:	Stem volume of trees of species or group of species j in plot p in stratum i
Source of data:	Local Growth Models
Value applied:	N/A
Purpose of the data:	Value used to determine the project ex – ante carbon sequestration
Any comment:	In case of ex-ante calculation, growth was estimated based on average growth according to specific site conditions presented in the project site. Local growth models were used for ex-ante estimation to describe the yield curve and determine the Long Term Average of available carbon credits. Local growth models will not be used for ex-post estimation which were based on field measurements: tree's DBH and height

Parameter:	Bark volume
Data unit:	m ³ /ha
Description:	Bark volume of trees of species
Source of data:	Methodological tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs"
Value applied:	15% of total stem volume
Purpose of the data:	N/A
Any comment:	The bark volume is a variable used in the ex-ante calculation. During field measurement, the volume of trees is estimated with bark when diameters are measured over bark.

Parameter:	SOC _{REF}
Data unit:	t C ha ⁻¹
Description:	Reference SOC stock corresponding to the reference condition in native lands (i.e. non-degraded, unimproved lands under native vegetation, normally forest by climate region and soil type applicable to stratum i of the areas of land under High Activity Clay soils (HAC))
Source of data:	Table 3 of "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM Project" activities.
Value applied:	88
Purpose of the data:	Used to estimate the carbon sequestration in soils
Any comment:	The <i>ex-ante</i> calculation for SOC change is modified under this verification, corrected by the modified total areas.

Parameter:	SOC _{REF}
Data unit:	t C ha ⁻¹
Description:	Reference SOC stock corresponding to the reference condition in native lands (i.e. non-degraded, unimproved lands under native vegetation, normally forest by climate region and soil type applicable to stratum i of the areas of land under Low Activity Clay soils (LAC))
Source of data:	Table 3 of "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM Project" activities.
Value applied:	63
Purpose of the data:	Used to estimate the carbon sequestration in soils
Any comment:	The <i>ex-ante</i> calculation for SOC change is modified under this verification, corrected by the modified total areas.

Parameter:	$f_{LU,i}$
Data unit:	Dimensionless
Description:	Relative stock change factor for baseline land-use in stratum i of the areas of land; dimensionless
Source of data:	Tables 6 of "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM Project" activities.
Value applied:	1
Purpose of the data:	N/A
Any comment:	The ex-ante calculation for SOC change was modified in the verification, corrected by the modified total areas.

Parameter:	$f_{MG,i}$
Data unit:	Dimensionless
Description:	Relative stock change factor for baseline management regime in stratum i of the areas of land, dimensionless
Source of data:	Table 6 of "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM Project" activities.
Value applied:	0.70
Purpose of the data:	Used to estimate the carbon sequestration in soils
Any comment:	The ex-ante calculation for SOC change was modified in the verification, corrected by the modified total areas. Lands are identified as degraded lands using the "Tool for the identification of degraded or degrading lands for consideration in implementing CDM A/R project activities".

Parameter:	$f_{IN,i}$
Data unit:	Dimensionless
Description:	Relative stock change factor for baseline input regime (e.g. crop residue returns, manure) in stratum i of the areas of land
Source of data:	Tables 6 of "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM Project" activities.
Value applied:	1
Purpose of the data:	Used to estimate the carbon sequestration in soils
Any comment:	The ex-ante calculation for SOC change is the same calculation as in the verification, corrected by the modified total areas.

Parameter:	Dead Wood
Data unit:	t C ha ⁻¹
Description:	Conservative default factor expressing carbon stock in dead wood as a percentage of carbon stock in tree biomass
Source of data:	Tool "Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities"
Value applied:	8% of carbon stock in trees biomass
Purpose of the data:	Conservative ex – ante and ex – post estimation of carbon in dead wood
Any comment:	This variable is introduced as a parameter available during validation, despite it was not used for ex-ante estimations but for ex-post estimations.

Parameter:	Litter
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Data unit:	t C ha ⁻¹
Description:	Conservative default factor expressing carbon stock in litter as a percentage of carbon stock in tree biomass
Source of data:	Tool “Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities”
Value applied:	4% of carbon stock in trees biomass
Purpose of the data:	Conservative ex – ante and ex – post estimation of carbon in dead wood
Any comment:	This variable is introduced as a parameter available during validation, despite it was not used for ex-ante estimations but for ex-post estimations.

3.2 Data and Parameters Monitored

Table 4. Data and monitored parameters.

Data Unit / Parameter:	A _i
Data unit:	ha
Description:	Area of stratum i
Source of data:	Monitoring of strata and stand boundaries was done using a Geographical Information System (GIS)
Description of measurement methods and procedures to be applied:	Strata area were measured based on cartography documents, related with GIS.
Frequency of monitoring/recording	Every time the project boundaries are modified. when disturbances events take place, the project participants shall re-built the stratum and add the area of the project under disturbance in the GIS
Value monitored:	4,987.91 ha
Monitoring equipment:	Garmin GPS, model eTrex Legend.
QA/QC procedures to be applied:	N/A
Calculation method:	N/A
Any comment:	As stated in the PD, Cambium Forestal S.A. is the manager of Forestal 'El Arriero S.A.' and continuously monitors the area of the forest plantations. The value was used in equations N° 3, 12 y 24 of the Methodological tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" (Version 03.0.0), Equations N° 7 and 13 of the Methodological tool "Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities" (Version 02.0.0)

Data Unit / Parameter:	DBH
Data unit:	cm
Description:	Diameter at Breast Height of tree

Source of data:	Field measurements
Description of measurement methods and procedures to be applied:	DBH is measured at 1.3 m above ground, over the bark. In case of stem deformation at this level, measurement was done over the deformation once the stem took its normal shape, with the purpose of being conservative. DBH was measured in all trees within the plots.
Frequency of monitoring/recording	Every tree within sample plots and 5 trees outside the plot of one plot per stratum
Value monitored:	6.496 values in 14 strata in 128 plots
Monitoring equipment:	In most of the cases, the instrument used for measuring DBH was a caliper model "Mantax Blue" of Haglof, Sweden; which image is following.  Also, for the minority of trees, it was used a diametric tape for measuring DBH. 
QA/QC procedures to be applied:	A quality control procedure consisted in staff member periodical training. The staff members were trained to make DBH measurements without errors: using firstly a measuring tape (to determine exactly where 1,3 meters height is located in their own bodies). Afterwards, they measured DBH in front of experts and member's staff to achieve procedures consistency. Quality assurance of DBH measurement is done through measurement of 5 trees surrounding one sample plot per strata. A "t" pair test is conducted to determine the correctness of obtained values

	with a 95% confidence level. This is also useful to demonstrate that sample plots, on which carbon stock is measured, were not treated differently from the rest of the forests (for instance treated with irrigation or fertilizers). Instruments were checked and tested before starting the verification process. Items checked: -Correct visualization if numbers in the calliper. -The straightness of the calliper and the lack of mechanical problems. The calliper length is not a problem since it is impossible the equipment stretches. Bark that is not stick to the stem was removed before measuring. Measurement was done once per tree, in one position pointing to the center of the plot with the caliper's blade.
Calculation method:	N/A
Any comment:	The trees are considered to be inside the plot if more than 50% of DBH is inside the plot. Diameters were measured by taking one measure, always pointing the instrument's shaft in direction to the middle of the plot. Parameter used indirectly in Equation N° 1 of the Methodological tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" (Version 03.0.0); for calculation of basal area and then volume..

Data Unit / Parameter:	H
Data unit:	m
Description:	Height of trees within sample plot
Source of data:	Field measurement
Description of measurement methods and procedures to be applied:	According to the most common practices applied in biometrics, the diameters of existing trees within a sampling plot are grouped in different classes. The different classes are formed by expert judge based on results obtained from DBH measurement.

	Following, one tree from the largest diameter class and one tree from the lowest diameter class will be measured in height and finally 5 additional trees are also measured trying to cover uniformly all the diameter variation range between both mark tree classes. The measurement was done according to the following procedure: • Identification of the individual tree to measure. • At the same level (independently that the measuring equipment corrects the value according to the slope). • The expert always tried to be situated at a certain distance to the tree equivalent to the height of the tree.
Frequency of monitoring/recording	7 trees per sampling plot and 5 trees outside the plot of one plot per stratum.
Value monitored:	994 different height values
Monitoring equipment:	Clinometer. See the following figure of the type of clinometer used during the monitoring events to measure tree heights. This image represents an electronic clinometer of Haglof, Sweden. 
QA/QC procedures to be applied:	Quality assurance of height measurement was done through the measurement of 5 trees surrounding one sample plot per strata. A "t" pair test was conducted to determine the correctness of the obtained values inside the plot with a 95% confidence level. This will also be useful to demonstrate that sample plots measured for carbon stocks calculations were not treated differently (for example with irrigation or fertilizers) from the rest of the forests. When referring to this electronic device, it is recommended to check the correct visualization of the display. The clinometer was always kept in safe places in order to avoid display rupture. The

	equipment was always full charge of batteries and back up batteries were always available in case of emergency. Make control measurements using all involved equipment (human error should be minimized at minimum with well training and cross-checked control measurement activities).
Calculation method:	Based on height values measured in the field and their respective DBH values, it was obtained a linear function of height (DBH) for each project region (TT, CL, CL-TT1 and CL-TT2). Functions were differentiated by region based on the fact that height is considered a site index. By using these functions, those height values not measured in field, were calculated for each individual tree in each plot for each stratum.
Any comment:	Parameter used indirectly in Equation N° 1 of the Methodological tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" (Version 03.0.0); for volume calculation.

Data Unit / Parameter:	Ap,i
Data unit:	m ²
Description:	Area of sampling plot
Source of data:	Field measurement
Description of measurement methods and procedures to be applied:	The center of the plot was marked with the assistance of a GPS. One staff member stayed at the center of the plot taking notes of the diameters and heights measured while the other expert of the team walked inside the plot measuring them. Both experts were always connected with a measuring tape, and every tree measured was previously checked in order to determine if the distance to the center was minor to 12.62 m (radius of a circular plot of 500m²).
Frequency of monitoring/recording	Every plot measured in El Arriero, 128 in total
Value monitored:	N/A

Monitoring equipment:	N/A
QA/QC procedures to be applied:	In order to avoid over and under-estimations, every tree was considered inside the plot when the mark of 12.62 m overpassed the 50% of the diameter of every tree.
Calculation method:	$500m^2 = r^2(12.62).\pi$
Any comment:	Sample plots are permanent and circular. The plots were laid down in a shapefile, positioned systematically with a random start. The location of the plots within the forest plantation was done with a GPS. The area of each plot is not a variable but a fixed value, but must be measured by its radius in order to determine the variable "number of trees within the plot".

3.3 Description of the Monitoring Plan

The aim of the Monitoring Plan is to record and monitor a number of different parameters in order to ensure that the project followed the corresponding methodology in the validated and registered PD and that the inputs to the carbon calculations are both accurate and up-to-date.

Monitoring was done according to the consolidated methodology AR-ACM 0001 "Afforestation and reforestation of degraded lands" (version 05.2.0, EB 65). The PD was registered mentioning the version 5.1.1 of the referred methodology but the applicable version is the one stated above. Analysis of its applicability conditions have been developed in section 2.2 of the PD.

Monitoring stage comprised gathering information, performing calculations and making estimations of GHG removals. In this monitoring event, it is ensured that commonly established principles of forest inventory and management were put into practice with the elaboration of a Monitoring Plan. Strictly speaking the document is called "Terms of Reference" (used in an open tender to receive monitoring services quotations) but it is used as a Monitoring Plan. This Monitoring Plan is a document prepared by Carbosur with the purpose of specifying the procedures and standardization for the measurement of each variable. This document is in Spanish and can be available for the verification team in a translated version in english. A summary of it was redacted to prepare the Terms of Reference of a tender. El Arriero released the tender and several forestry consultancy companies compete to provide the lower price for the same price in equal quality terms.

All data gathered as part of the monitoring plan was archived electronically and will be kept at least for two years after the end of the crediting period.

According to the methodology applied, monitoring covered carbon stock changes for living above-ground, litter and dead wood pools. Below ground biomass was estimated indirectly based on above-ground biomass measurements and litter and dead wood were finally estimated as a percentage of carbon stock in tree biomass.

Monitoring event took place between November, 27th 2012 and March, 25th 2013. The third party involved in this stage was "Pike & Co. Consultora Forestal" as the awarded of the tender. It is a Uruguayan consultancy and services company, specialized in forest inventories.

Pike & Co.'s staff was compound by 8 persons during the monitoring events. They worked divided by project zones in two groups: 4 members were assigned to Cerro Largo zone and another 4 were assigned to Treinta y Tres zone. Besides, those groups were sub-divided, resulting in two teams composed by 2 persons each. During this work the locomotion consisted of two trucks and four motorbikes.

With the purpose of controlling and checking the measurement equipment and measuring team capabilities, Pike & Co. staff was requested to randomly re-measure 10% of total number of plots, which resulted in 7. The staff in charge of this work was different from the one who made the first measurement on the same plot. If the difference between both measurement of the same plot would have been greater than 5% in carbon stock, the plot should have been re-measure for a third and definitive third time. If the difference between both sample plots would have been higher than 10%, this sample plot should have been definitely eliminated from the total estimation of carbon stock according to the PD. As described above, the final decision was to use the measurement with the lowest values.

Once the monitoring event was finished and during field data processing, it was found an error about the number of plots measured in various strata. In order to revert that situation, Carbosur Ltda. proceeded to hire statistics expert services. The result of the statistic study consisted of the need to re-calculate the number of plots on those strata, and as a consequence, to increment the number of necessary sample plots per stratum in order to achieve statistical confidence. In those strata where only one plot was measured, another plot was added, resulting in a total and minimum number of two plots per stratum. Also, the number of plots was wrongly calculated in some strata during validation. The additional new sample plots were measured during a second monitoring event (see table 8 below), which was completed between 19th and 25th March, 2013.

Sampling design and stratification

Project boundaries were defined at the beginning of project activity and the same geographic boundary will be maintained, according to VCS AFOLU requirements. However, the project area will be permanently monitored along the crediting period, since new strata may be created after potential disturbances effects (pests, droughts, fire).

The monitoring of boundaries could also result in the detection of new forest area, which will not become part of this project at any time. When a reduction in the forest area is detected, the project participant will analyze the difference and if it is due to minor corrections in the Geographical Information System the new total area will be presented in the next verification with a detailed explanation of the modification, but the project boundaries will always be the same. If the reduction in the forest area represents a reversal (according to the VCS document Program Definitions) or a catastrophic event, then the project participant will have to communicate this to the VCS and monitor the loss. None of these situations have occurred within Arriero's project boundaries.

Geographic coordinates are established, recorded and archived. A Geographic Information System was implemented for the validation and is updated for verification. All the geographical information will be available for the verification team.

With the purpose of developing the monitoring plan, Forestal 'El Arriero S.A.' was stratified into 14 strata. Stratification was done considering region; age class (plantation date); and species planted (*Pinus taeda* and Hybrid pine caribea x elliotti). Project boundaries did not suffer any disturbance and the strata was not subdivided or merged. However, insignificant intra-stratum variability is detected in some stratum and it is highly possible that there will be fewer stratums in the next monitoring report.

Permanent sampling plots are selected, since these are considered to be more efficient for estimating changes in carbon stocks by filtering out any variance due to plot effect. The plots allocation is registered in a GIS and can always be located. The plots were established at the field with a stick painted in white at the center of the plot and are highly probable it can be found after two or more years.

The location of the plots followed the guidance given by the corresponding methodological tool, as well as IPCC Good Practice Guidance for LULUCF (2002), chapter 4.3. An Arc-Map software (NAPA) developed by Pike & Co. was used to randomly locate the permanent sampling plots (location is systematic, with random start). This software has a feature to enable the location of all plots on forest areas (i.e., it avoids

plots from being located in firebreaks and other non-planted areas). The map with the location of the sampling plots was loaded on the GPS receptors used by forest inventory crews, so that they can reach the plots accurately. An example of the software output for two contiguous strata is shown in Fig. 7.

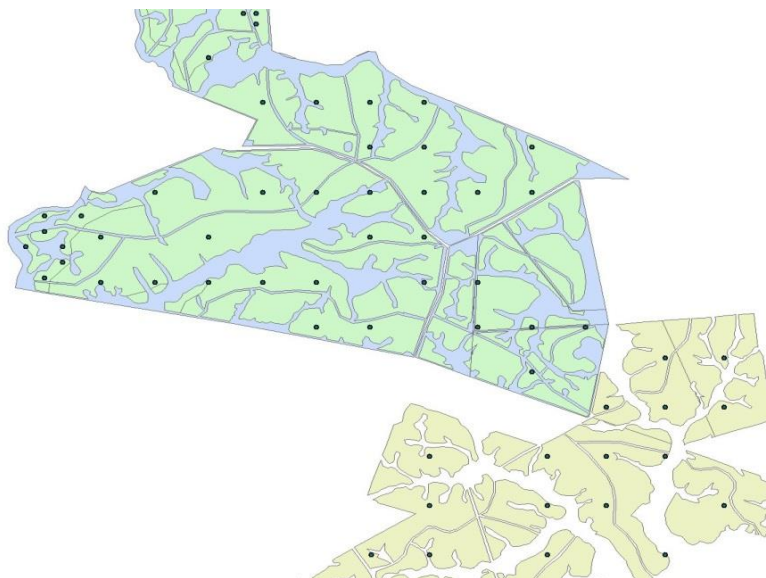


Figure 8. Example of location of permanent sampling plots.

The following table shows the number ex-ante and ex-post of plots per stratum.

Table 5. Number of sample plots per stratum.

Region	Stratum N°	Specie	Year plant.	Ex - ante		Ex - post	
				Area (hectare)	Plot/Stratum	Area (hectare)	Plot/Stratum
CL	1	HYB	2010	55	1	54.37	2
	2	PT	2010	1,272	23	1,208.15	19
	3		2011	46	1	133.05	2
CL-TT 1	4	HYB	2009	23	1	23.57	2
	5		2010	34	1	33.64	2
	6	PT	2009	1,684	31	1,352.65	54
	7		2010	592	11	544.6	9
	8		2011	37	1	6.58	2
CL-TT 2	9	HYB	2010	30	1	31.56	2
	10	PT	2009	303	6	302.47	10
	11		2010	790	14	786.17	12
TT	12	HYB	2010	29	1	28.9	2
	13	PT	2009	152	3	151.98	5
	14		2010	330	6	330.22	5
Total				5,377.0	101	4,987.91	128

Each carbon pool was measured following the methodology procedures and IPCC Good Practice Guidance for LULUCF (2003) established in the PD and Monitoring Plan. Carbon stocks in above and below ground biomass of trees are estimated by applying the BEF method, which calculates the biomass of trees of each species per unit area in each stratum at a given point of time, based on the following three dimensions: diameter, basal area and height, obtained from field measurements. By applying BEF method, volume equations are used to convert tree dimensions to stem volume of trees based on DBH and height measurement in each plot. Stem volume of trees is then converted to above-ground and below-ground tree biomass using basic wood density (D), biomass expansion factor (BEF) and root-to-shoot ratio (R). Default carbon fraction (CF) value was used in order to estimate the carbon stock.

Prior to the start of the inventory, all equipment used during the field work was checked and calibrated.

Managing data quality

A Quality Control System will be implemented for routinely checking for data consistency, correctness and completeness; for identifying and correcting errors and omissions; and for properly documenting and archiving data and documentation related with the monitoring activities. Quality Assurance measures will be implemented, in order to verify that data quality objectives are met, and in general, to support the effectiveness of the QC system.

QA/QC plan includes a number of activities aiming at achieving accuracy and precision of data, and transparency of procedures, such as:

- development of Monitoring Plan for field measurements, clearly defining all staff responsibilities and raising awareness about the importance of each tasks for producing reliable results;
- proper training of field measuring teams as the training all staffs members received previous to the field data collection;
- periodical check and maintenance of measuring instruments; all mechanical, optical and electronic instruments were periodically checked by qualified personnel. In addition, consistency on field data will be permanently monitored, in order to detect any malfunctioning. The equipment was calibrated periodically. The calipers, diameter and meter tapes were weekly contrasted with a master tape.
- development of electronic worksheets spots cheks;.
- fully document and archive field and processed data, as well as all procedures used; to ensure data preservation, all relevant data, data analyses, static factors, photos, images, GIS output and other data shall be stored in electronic and paper format. The information is kept in serves which are weekly backed up in an external drive.
- establish procedures for eliminating inconsistent or erroneous field data; perform random checks of field measurements in order to detect measurement errors or systematic biases; some of such measures were: 1) hire independent workers for transferring field data to digital media. (IPCC GPG 5.3.6.1); 2) during field work, double checked 10% of sampling measurements with an independent party team or with a team different from the one that performed the measurement or sampling; 3) establish procedures to ensure representativeness of PSPs (i.e., if a plot was located in a non-representative area, the plot was relocated some few meters until finding a representative area); the allocation of samples in the field will be systematic with random start, so, the differences between population and sample mean and variance tend to be neutralized; identification of plots in the field are coded and recognizable only to the monitoring team; 4) periodical checks were be performed on simple measurements (e.g., DBH of five trees outside PSPs, in order to correlate these values with plot measurements;

Operational and management structure

The monitoring was coordinated by the property manager and implemented by a qualified contractor. One staff member of Forestal 'El Arriero S.A.' was identified as the focal point.

Entity applying monitoring plan:

Company: Forestal 'El Arriero S.A.'

Address: Av. Luis A. De Herrera 1248, Piso 12

City: Montevideo

Zip code: 11.300

Country: Uruguay

Phone: +598 2 6285029

Monitoring event was developed by the consultant Pike & Co.

Entity applying monitoring event in 2012 – 2013:

Company: 'Pike & Co. Consultora Forestal'

Phone: +598 2 916 1085

www.pikeconsultora.com.uy

Carbon estimations and general calculations was developed by Carbosur.

Company: Carbosur Ltda

Phone: +598 2 915 3514

www.carbosur.com.uy

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

Since continuation of an activity that has been applied without changes for more than 20 years has been selected as the baseline scenario, it is assumed, in agreement with IPCC Good Practice Guidance for Land Use, Land Use Change and Forestry (2003) that the net GHG removals by sinks in the baseline equals zero.

4.2 Project Emissions

Forestral 'El Arriero S.A.' project activity does not have GHG emissions. However, this chapter refers to the removals of GHG performed by this project activity.

Net anthropogenic GHG removals by sinks is estimated as the actual net GHG removals by sinks minus the baseline net GHG removals, minus leakage. The following general formula described in the methodology is used to calculate the net anthropogenic GHG removals by sinks of an A/R project activity, in t CO₂-e:

$$C_{AR-CDM} = \Delta C_{ACTUAL} - \Delta C_{BSL} - LK$$

Where:

C_{AR-CDM} Net anthropogenic GHG removals by sinks; t CO₂-e.

ΔC_{ACTUAL} Actual net GHG removals by sinks; t CO₂-e.

ΔC_{BSL} Baseline net GHG removals by sinks; t CO₂-e.

LK Total GHG emissions due to leakage; t CO₂-e.

The actual net greenhouse gas removals by sinks were estimated using the following equation described in the methodology:

$$\Delta C_{ACTUAL} = \Delta C_P - GHG_E$$

Where:

ΔC_{ACTUAL} Actual net greenhouse gas removals by sinks; t CO₂-e.

ΔC_P Sum of the changes in above-ground and below-ground tree biomass, dead wood, litter and soil organic carbon stocks in the project scenario; t CO₂-e.

GHG_E Increase in GHG emissions as a result of the implementation of the proposed A/R CDM project activity within the project boundary; t CO₂-e.

The following formula described in the methodology is used in order to estimate GHG emission:

$$GHG_E = \sum_{t=1}^{t^*} GHG_{E,t}$$

Where:

GHG_E Increase in GHG emissions as a result of the implementation of the proposed A/R CDM project activity within the project boundary; t CO₂-e.

$GHG_{E,t}$ Increase in non-CO₂ emissions due to biomass burning of existing vegetation as part of site preparation in year t; t CO₂-e.

t 1,2,3,.....,t* years elapsed since the start of the A/R CDM project activity.

The tool for “Estimation of non-CO₂ GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity” has been considered. The use of fire for site preparation and/or to clear the land of harvest residue prior to replanting is specifically excluded from the project management and therefore project emissions are estimated as zero.

Carbon stock changes

ΔC_P is the sum of the changes in above-ground and below-ground tree biomass, dead wood, litter and soil organic carbon stocks in the project scenario. For ex-ante estimation, all pools were accounted. Following is presented the equation for the estimation of ΔC_P . Calculations are described below.

$$\Delta C_P = \Delta C_{TREE} + \Delta C_{DW} + \Delta C_{LI} + \Delta C_{SOC}$$

Where:

ΔC_P Change in carbon stock in all selected carbon pools in the project scenario, t CO₂-e.

ΔC_{TREE} Change in carbon stock in tree biomass in project, 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 CO₂-e.

ΔC_{DW} Change in carbon stock in dead wood biomass in project, as estimated in the tool “Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities”; t CO₂-e.

ΔC_{LI} Change in carbon stock in litter biomass in project, as estimated in the tool “Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities”; t CO₂-e.

ΔC_{SOC} Change in carbon stock in SOC in project, in areas of land meeting the applicability conditions of the tool “Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities”, as estimated in the same tool; t CO₂-e.

Biomass carbon pools

Above and below ground biomass have been estimated according to the tool “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activity”. Carbon estimations in trees are based on field measurements of monitored parameters, chapter 3.2 of the Monitoring Report. Estimations are archived as part of the project verification and will be available for the verification team.

The aboveground biomass corresponds to tree biomass, no shrubs are considered for estimation. The method used for estimating change in carbon stock in trees is the “stock change method”. Change in carbon stock in trees in two successive points in time is calculated as the difference between the two estimated stocks. As this is the first monitoring report the carbon values in every pool is the final result, the starting point of the crediting period is zero carbon.

As in ex-ante estimations, the following equations were used in order to estimate above and below ground biomass ex-post measurements:

$$B_{TREEj,p,i,t} = V_{TREEj,p,i,t} * D_j * BEF_{2,j} * (1 + R_j)$$

Where:

$B_{TREE,j,p,i,t}$ Biomass of trees of species j in sample plot p of stratum i at late 2012 – early 2013.

$V_{TREEj,p,i,t}$ Stem volume of tree species using field measurements of tree parameters (DBH and height), default values (tree shape factor) and complemented with worksheets data processing (interpolation of not-measured heights); m³.

The applied equation for volume estimation is no other formula than the cylinder volume equation corrected by a taper value (TSF):

$$V_{TREE} = Basal\ area \times height \times TSF$$

Where:

$$Basal\ area = \frac{\pi \times DBH^2}{4}$$

DBH: Diameter at Breast Height

TSF: Tree Shape Factor

According to the methodology, for ex post estimation, the volume equation used must be demonstrated to be appropriate for the purpose of estimation of tree biomass by applying the tool “Demonstrating appropriateness of volume equations for estimation of aboveground tree biomass in A/R CDM project activities”. The appropriateness of the equations is demonstrated through the satisfaction of the following conditions, in the sense that the formula is very generic and applicable in any case:

- The equation is used both in the national forestry inventory and the national GHG inventory of Uruguay, and
- The equation has been used in commercial forestry sector in Uruguay for 10 years or more.

During verification visit, PP decided to use other TSF values. This new values corresponds to real TSF values obtained by tree age, by Cambium. A document containing explanations about the procedures followed in order to obtain these values is attached to this sheet.

For those pine plantations from years 2011 and 2012 (ages of 1 and 2 years), the tree shape factor value to be used is equal to 2010 plantations value, due to the lack of a tree shape factor value for these ages. The tree shape factor values used in El Arriero carbon stock calculations figure in Table 6.

Table 6. Tree Shape Factor values developed by Cambium S.A.

Plantation year	Age	TSF over bark
2010	3	0,735456053
2009	4	0,565965911

D_j Basic wood density of tree species j. The species j corresponds to the only species used in this project: *Pinus sp.*, with a basic density of 44 t.d.m./m³. This parameter was established as “available at validation” in the Project Design, thus it was not measured or monitored. The value was obtained and corresponds to default value for *Pinus pinaster* in IPCC LULUCF Good Practice Guidance (2003), Table 3A.1.9-1(http://www.ipcc-nggip.iges.or.jp/public/gpplulucf/gpplulucf_files/Chp3/Anx_3A_1_Data_Tables.pdf).

As also established in the validation report, the applied value is also mid-range in values for loblolly pine wood density published by Oregon State.

$BEF_{2,j}$ Biomass expansion factor for conversion of stem biomass to above-ground tree biomass, for tree species j (*Pinus sp.*); dimensionless. The BEF_2 is to be used in connection to growing stock biomass data and not with increment data, as described in chapter 3.2 of the GPG for LULUCF (2003)). The value was also available at validation and not monitored, it ranged from 3.4 (for young forest) to 1.15 (mature forests) and the exact values applied for different plantation dates are reported in the final worksheet for carbon stock calculation.

R_j Root-shoot ratio for tree species j ; dimensionless. The values applied were taken from the suggested equation from the tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs":

$$R = \frac{\exp[-1.085 + 0.9256 \times \ln(A)]}{A}$$

Where A is aboveground biomass content (t.d.m/ha). The aboveground biomass was calculated per year of plantation and different values were obtained. See Table 6 with the results of the estimation.

Table 7. Aboveground biomass and R values estimated by year of plantation.

Year of plantation	Aboveground biomass (t.dm/tree)	R estimated based on the aboveground biomass measurement (dimensionless)	R Used for ex-ante estimations in and approved in validation
2009	7,29	0,2917	0,26
2010	2,22	0,3149	0,27
2011	0,06	0,3743	0,27
2012	0	0,3743	0,29

By default, for plantations of year 2012, the value of R was considered the same as in plantations of year 2011. The following figure illustrate the values of measured on field aboveground biomass (t.d.m./ha) and the corresponding value for R (dimensionless).

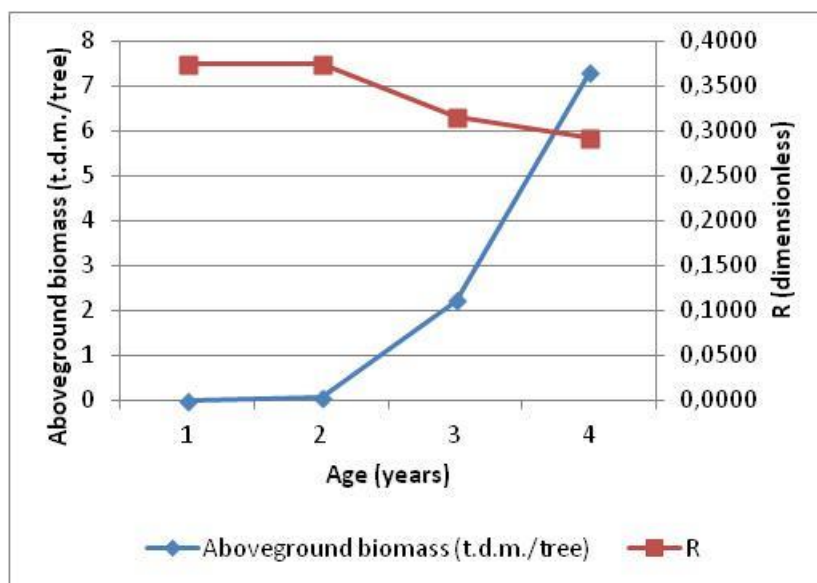


Figure 9. Relationship between aboveground biomass (t.d.m./ha) root-shoot factor (R).

Following paragraph 23 to 31 (equation 5, 6, 7, 8, 9, 10, 11 and 12) of the tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs", the total tree biomass and the uncertainty of the mean tree biomass per hectare within the project boundary is estimated.

Finally, the carbon stock in tree biomass within the project boundary is estimated as follows:

$$C_{TREE} = \frac{44}{12} * B_{TREE} * CF_{TREE}$$

Where

C_{TREE} Carbon stock in tree biomass within the project boundary; t CO₂-e.

B_{TREE} Biomass of trees within the project boundaries.

CF_{TREE} Carbon fraction of tree biomass; 0.5 t C td.m-3.

Soil organic carbon

Estimations of soil organic carbon (SOC) stocks were done in accordance to the "Tool for the estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activity". As suggested by the tool, it is assumed that the implementation of the project activity firstly decreases the SOC content of the lands from the pre-project level due to the site preparation. Afterwards, the SOC increases to the level that is equal to the steady-state SOC content under native vegetation. The increase in SOC content in the project scenario takes place at a constant rate over a period of 20 years from the year of planting. The project meets the applicability conditions of this tool -as demonstrated in validation- since the areas of land to which the tool is applied do not fall into wetland category, do not contain organic soils and are not subject to any of the land management practices and application of inputs listed in the tool.

Litter remains on site and is not removed and soil disturbance is in accordance with appropriate conservation practices, limited to site preparation and not repeated within 20 years.

Table 8. Parameters used for estimation of Soil Organic Carbon (SOC).

Parameter	Symbol	Value	Source (SOC estimation tool, V01.1.0)
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Reference SOC (tC/ha)	$SOC_{REF,i}$	88	Table 3. HAC soils, warm temperate, High Activity Clay soils
Reference SOC (tC/ha)	$SOC_{REF,i}$	63	Table 3. HAC soils, warm temperate, Low Activity Clay soils
Land use factor	$f_{LU,i}$	1	Table 6. All permanent grassland
Management factor	$f_{MG,i}$	0.70	Table 6. Severely degraded grassland. Lands are identified as degraded lands using the “Tool for the identification of degraded or degrading lands for consideration in implementing CDM A/R project activities”
Input factor	$f_{IN,i}$	1	Table 6. Grassland without input of fertilizer

The correspondent carbon sequestration calculation is presented to the verification team in the total carbon stock estimation worksheet.

Litter and Dead Wood

Estimations were done in accordance with the tool “Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities” using a default and conservative value of 8% and 4% of carbon stock in tree biomass for dead wood and litter respectively.

4.3 Leakage

As it has been stated in PD document, the methodology requires the assessment of sources of leakage due to activity displacement (conversion from grazing land to forestry). Application of the tool “Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity” led to the conclusion that this source can be neglected. The application of the “Guidelines on conditions under which increase in GHG emissions related to displacement of pre-project grazing activities in A/R CDM project activity is insignificant”, which is one of the applicability conditions of the tool, resulted in the conclusion that the project will not cause any displacement of the activity occurring before project implementation. The project accomplishes the following conditions:

(b) The total area expected to be displaced is more than 5% of the entire A/R CDM project activity or more than 50 ha, and the $n - a$ ha (where “n” is the area in ha expected to be displaced and “a” is 5% of the total project area or 50 ha) are displaced to:

- i. Areas of land that can be identified as degraded or degrading.
- ii. Existing grasslands with the carrying capacity that allows for accommodation of the displaced animals during the entire period of displacement.

The total area to be displaced corresponds to the total area of the project 4,987.91 ha, meaning that the grazing area displaced is 100% and also more than 50 ha, then the value $n - a$ is $4,987.91 - (5\% \text{ of } 4,987.91 = 249.4) = 4.738,5$. This area, used for grazing cattle, can be identified as degraded.

- (i) The grazing cattle displaced by Arriero’s project will be to neighbor areas. One of the main explanations are that the project areas are not located in only one farm but in 4 different areas (as seen in Figure 2. It was already demonstrated that the project areas are degraded or degrading,

and because the grazing animals are moved to neighbor zones, the same conditions applies to this specific soil.

(ii) Moreover, the animals will be displaced only for 2 to 3 years and later returned to the same site. The silvicultural management practice does not permit the animals to be grazing at the same time with the small trees, to avoid any physical damages. When the trees are big enough 2 or 3 years, the animals are reintroduced. During the period when the animals are displaced, the grasslands to where they go have the carrying capacity, as seen in table 10 of the PD document, the majority of farms in the project area (64%) are dedicated to beef cattle production. In Uruguay 80% of the land is dedicated to grazing animals.

(d) The total number of animals expected to be displaced is more than 40 LSU, and the $n - 40$ LSU (where "n" is the total number of animals, expressed in LSU, which are expected to be displaced) are displaced to:

- i. Areas of land that can be identified as degraded or degrading
- ii. Existing grasslands with the carrying capacity that allows for accommodation of the displaced animals during the entire period of displacement
- v. Slaughterhouses

Option (i) and (ii) were already demonstrated above. Option (v) is also valid for the case of El Arriero project. This is a common practice in the cattle beef production in Uruguay.

Most of the supporting evidence for the above paragraph demonstration can be obtained through the observation of the Uruguayan farms and its cattle production system during on-site validation.

Beyond all, we believe the application of the tool "Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity" is not necessary. The application of the "Guidelines on conditions under which increase in GHG emissions related to displacement of pre-project grazing activities in A/R CDM project activity is insignificant", which was superseded by the previously mentioned tool, resulted in the conclusion that the project will not cause any displacement of the activity occurring before project implementation.

Beef cattle breeding (cow-calf) was the dominant activity in the pre-project land (Eastern hilly areas of Uruguay). Cattle were based on a breeding herd where heifers are mostly placed with bulls at the age of 3 years. Sales include culling cows to be fattened, surplus heifers, and calves (at weaning). Average production is 33 kg per ha per year⁵.

Considering the area subject to be afforested represents only 45-50% of the total area owned by the project participant (lowlands, biological corridors, roads, rocky areas, settlements, among others, complete the rest of the land use), the displacement of grazing activity can be considered neglected because:

- Uruguayan grazing activity is completely associated with forestry. A larger amount of cattle, more than what is usual, is put within the project area during some months to substantially reduce the amount of above ground biomass minimizing the use of glyphosate (herbicides for site preparation) during site preparation for the forest establishment.

⁵ INIA., 2001. Tecnologías forrajeras para sistemas ganaderos de Uruguay. Boletín de Divulgación 76.

- During site preparation and for a maximum of two years after forest establishment, cattle is put apart in similar areas (commonly in neighbors farms) to prevent cattle from harming the small trees. During the period in which cattle lose the winger part of leather, it is very common the animal uses fences or trees to scratch. After these two years cattle is reintroduced and managed in a silvopastoral system with trees (both activities complement each other). The impact of cattle displacement is reduced to two years over thirty year rotation.

- The total area under project activity is not afforested in the same year, *first areas were planted in 2009 and the last ones in 2011.*

- The impact of this staggered plantation plan substantially reduces the eventual grazing displacement, cattle that has to be moved to other areas can be put in farms that were not afforested or in areas that has more than two years with forestry owned by El Arriero.

It is important to emphasize that the 5.073,3 hectares that comprises El Arriero's forests were not planted all at a same time, so animals are displaced gradually to other lands, following the sequence of plantations.

- Silvopastoral production is conducted during twenty two years of the twenty four year rotation period. Silvopasture combines trees with forage and livestock production. The trees are managed for high-value sawlogs and, at the same time, provide shade and shelter for livestock and forage, reducing stress and increasing forage production



Figure 10. Silvopastoral system in Uruguay

- During one and a half year –maximum two –cattle is put in existing grasslands with the carrying capacity that allows for accommodation of the displaced animals during this period of displacement. These are areas with no forest (80% of Uruguayan surface is pasture) meaning that deforestation never occurs when introducing cattle in farms. And these areas can be identified as degraded.

- Existing cattle in the pre-project situation may either stay within project boundaries or in an area controlled by project participant, or be sold to the market (calves and surplus heifers are normally sold in the market for fattening on other grazing areas, while cows, heifers and a reduced number of bulls are sold to slaughterhouses). It is El Arriero's policy that land owners can continue with their activities for a certain period of time after the purchase of the land, so that they have time to reduce the population of their cattle. In some cases, they may even stay in the land.

Furthermore, according to data gathered from governmental Livestock Controller Division (DICOSE)⁶ there has been a smooth increase in the beef cattle number of heads at a national level (Figure 10).

On the other hand, according to data taken from National Forest Directorate (DGF)⁷ forest plantations have also been increasing for the same period of time (Figure 10). In addition, native forest has been also increasing in terms of area in the last 43 years at the National level. According to National Forest Inventory (2010)⁸ and to the forest maps based on aerial photographs of 1967⁹ native forests have increased 21% in terms of area. The fact that total forest area and amount of livestock have been increasing is evidence that project activity does not result in displacement of the previous productive system. Therefore, leakage is assumed to be zero.

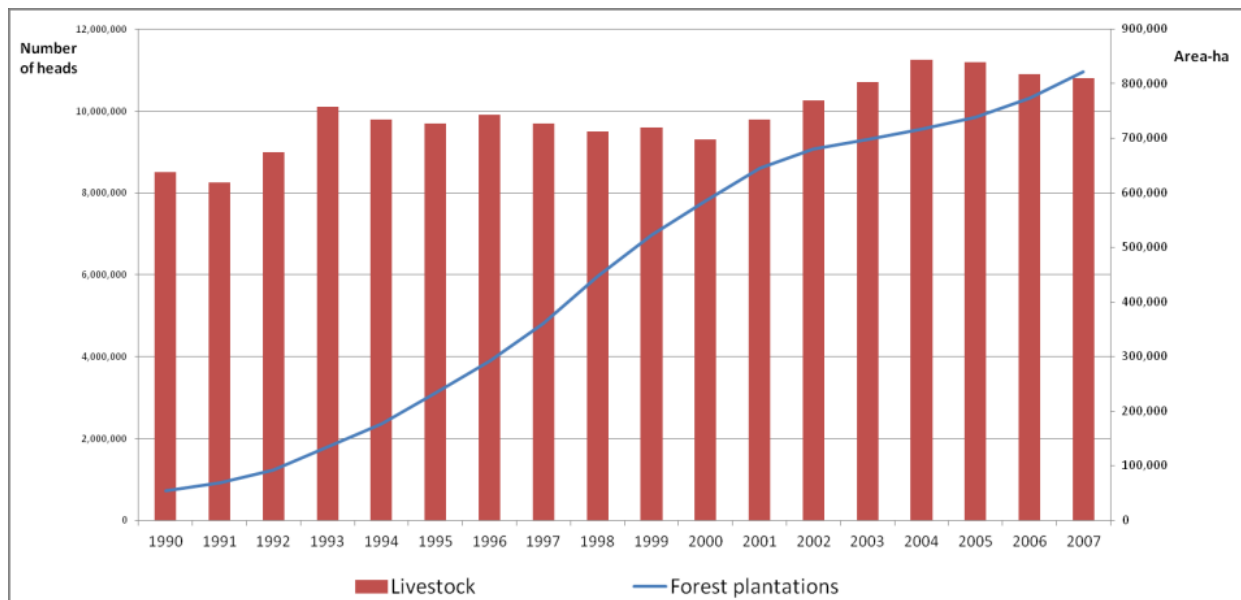


Figure 11. Blue curve shows the evolution of grassland area converted to forest plantations. Red bars show the number of cattle heads in each year. Statistics were taken from official sources at a national scale.

4.4 Summary of GHG Emission Reductions and Removals

The final results for aboveground and below ground are presented below, distinguished by plantation year.

Baseline net GHG removals and total GHG emissions due to leakage are zero, thus ex-post measurement of C_{AR-CDM} equals ΔC_{ACTUAL} :

⁶ <http://www.mgap.gub.uy/DGSG/DICOSE/Informe2007/gravaccar2007.ppt>

⁷ <http://www.mgap.gub.uy/portal/hqxpp001.aspx?7,20,442,O.S.O,,>

⁸ <http://www.mgap.gub.uy/portal/hqxpp001.aspx?7,20,440,O.S.O,,>

⁹ URUGUAY MAP. Forest Directorate.- First Forest Chart. Montevideo: MAP, 1979
([http://www.mgap.gub.uy/portal/hqxpp001.aspx?7,20,410,O.S.O,MNU;E:2;15;125;1:MNU;,"](http://www.mgap.gub.uy/portal/hqxpp001.aspx?7,20,410,O.S.O,MNU;E:2;15;125;1:MNU;,))

Table 9. Summary of 'El Arriero S.A.'s Emission Reductions and Removals.

tCO2	Above and belowground biomass	Dead wood	Litter	SOC	Total
Planted in 2009	35.700	2.856	1.428	-14.184	25.800
Planted in 2010	27.275	2.182	1.091	-22.941	7.607
Planted in 2011	35	3	1	-2.838	-2.799
Total	63.010	5.041	2.520	-39.964	30.608

According to VCS version 3, AFOLU requirements, the amount of carbon credits must not exceed the long term GHG benefit of the project which is 1.827.052 t CO₂.

Uncertainty of tree biomass per hectare

According to the instructions given in Version 03.0.0 of "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/RCDM project activity" tool, uncertainty of tree biomass per hectare within the project boundary was calculated, using the following formula:

$$u_{bTREE,t} = \frac{t_{VAL} \times S_{bTREE,t}}{b_{TREE,t}}$$

Where:

$u_{bTREE,t}$ Uncertainty of tree biomass per hectare within the project boundary at a given point of time in year t, %.

t_{VAL} Two – sided Student's t-value for: (i) Degrees of freedom equal to n-M, where n is total number of sample plots within the project boundary, and M is the total number of tree biomass estimation strata; and (ii) a confidence level of 90%.

$t_{S_{bTREE,t}}$ Square root of the variance of mean tree biomass per hectare within project boundary at a given point of time in year t (i.e. the standard error of the mean); t d.m.ha-1.

$b_{TREE,t}$ Mean tree biomass per hectare within the project boundary at a given point of time in year t; t d.m.ha-1.

In order to assure the reliability of the obtained results, a statistical analysis was done, including three items:

- Calculation of the uncertainty of the mean tree biomass per hectare within the project boundary, by applying the formula stated above.
- Randomly re-measure of 10% of the measured number of plots, resulting in 7 “control plots”. The staff in charge of this stage had to be different from the one who firstly made the measurements. If in any plot there was a difference higher than 5% in carbon stock, the company in charge of measurements should measure for a third and definitive time that specific plot. If the difference between both sample plots is higher than 10%, this sample plot with the lower volume value was used for the total estimation of carbon stock.
- In order to follow the QA/QC standards it was necessary to ensure that there was no significant difference between inside-plot volume values and the volume of 5 trees randomly measured outside the plots. For this stage there were randomly selected 91 sample plots.

Regarding the uncertainty of the mean tree biomass per hectare within the project boundary, the obtained value resulted in 8,055% which means that the value of GHG Emission Reductions and Removals (tCO₂) calculated is reliable. Calculations were based on α value of 0.1.

About the second point, the result was that with 95 % confidence level it is possible to state that 3 out of 7 “control sample plots” have a significant difference between both measurement groups averages, corresponding to the following sample plots: 1, 63 and 151. In all of the cases this difference was higher than 10%. To those plots showing higher than 10% differences, it was decided not to consider those sample plots having higher averages and consider the sample plots with lower mean volume value for the account of the total carbon stock estimations. To sum up, volume estimations of plots N° 63 and 151 were substituted by volume values of plots V63 and V151 (nomenclature corresponded with Excel sheets. In case of plot N°1, the average volume value was higher in the verification plot, so the original sample plot value was used.

Finally, regarding the QA/QC analysis, the result was that 28 of 90 sample plots showed significant differences between results inside and outside the plots. Of those 28 plots showing significative difference, 15 showed a higher average on the original sample plot over the outside-plot measured trees average. These special cases are sample plots N° 5, 7, 9, 16, 18, 21, 22, 26, 31, 33, 41, 59, 138, 155 and 156.

Emission Reduction by Year

The Current Annual Increment (CAI), which is the increment, gained by a tree on in a single year for each species/genus was estimated from the field data and used to distribute the total carbon stocks in different years.

After obtaining the CAI values, it was calculated the annual growth by year (m³/year) and the percentage of GHG Emissions Reductions and Removals by year on the forests within the project boundaries.

Table 10. ‘El Arriero S.A.’s total GHG Emission Reductions and Removals by year and by forest age (tCO₂).

Planted Year	2009	2010	2011	2012	TOTAL
Age	1	2	3	4	
Planted in 2009	-3,546	-3,027	14,467	17,906	25,800
Planted in 2010	0	-7,647	-6,791	22,045	7.607
Planted in 2011	0	0	-1,419	1,380	2,799
TOTAL (tCO ₂)	-3,546	-10.674	6,256	38,571	30,608

Vintages

Forestal ‘El Arriero S.A.’ Project will not consider vintage in an annually-basis, given the provisions stated in the VCS Registration and Issuance Process, v3.5_0, page 14 where it is specified that “due to the intricacies of accounting for GHG emission reductions and removals in AFOLU ARR and IFM projects with harvesting, such projects may not break down verification periods into vintage periods when any year

within the verification period has a negative number of GHG emission reductions or removals. For such projects, the vintage period shall be equivalent to the verification period

5 ADDITIONAL INFORMATION

N/A