

REFORESTATION WITH TEAK CO₂e TEAKMEX



Document Prepared By
South Pole Carbon Mexico S.de R.L.de C.V.

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1 PROJECT DETAILS

1.1 Summary Description of the Project and its Implementation Status

The forestry project “Reforestation with Teak - CO₂e TEAKMEX” is an ARR grouped reforestation carbon project based on the planting of *Tectona grandis*. The region of expansion of the grouped project covers the states of Tabasco, Chiapas and Campeche in the United States of Mexico. Within these states, the project area of the first instance spans 4,011.96 ha¹ across five municipalities: Balancán (Tabasco), Huimanguillo (Tabasco), Tenosique (Tabasco), Palenque (Chiapas), and Candelaria (State of Campeche). These municipalities are all rural, and extensive livestock farming is the primary land use, followed by agriculture.

The project will significantly contribute to the sustainable development of these Mexican states through creating a sustainable supply chain for Teak. This involves: i) providing formal employment opportunities in regions largely characterized by informality; ii) converting land that has previously been cleared for livestock and agriculture purposes into forested lands, so increasing carbon sequestration for the mitigation of global warming; and iii) maintaining fixed conservation areas within commercial plots, in order to enhance and conserve biodiversity in these lands.

The project activity started on June 30th, 2013. The early-stage revenues derived from the resulting carbon credits contribute to the success of forestry projects because the income is used as a resource to overcome several obstacles faced by the project activity. Implementation of the project is expected to create positive net climate change impacts. The increase in forest cover and sequestration of carbon through living biomass in the first instance will contribute to the reduction of greenhouse gas emissions by acting as sinks, sequestering an average of 44,988 tCO₂e per year on the period 2013-2049.

1.2 Sectoral Scope and Project Type

The project corresponds to VCS scope 14 “Agriculture, Forestry and Other Land Use” as an Afforestation, Reforestation and Revegetation (ARR). The project is a grouped project.

1.3 Project Proponent

Organization name	Agropecuaria Santa Genoveva S.A.P.I. de C.V.
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Title	General director
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¹ Eligibility of year 2017 can be adjusted

1.4 Other Entities Involved in the Project

Organization name	South Pole Carbon Mexico S.de R.L.de C.V.
Role in the project	South Pole creates and oversees the development of appropriate project design and monitoring techniques in line with the guidelines of the VCS.
Contact person	Daniela Herrera
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1.5 Project Start Date

June 30th, 2013. Seeding activities began on this date in plot 42, farm Doña Carmina².

1.6 Project Crediting Period

For the current grouped project, the crediting period will be 36 years and 0 months. The period starts on *June 30th, 2013*, and ends on *May 31st, 2049*.

1.7 Project Scale and Estimated GHG Emission Reductions or Removals first instance

Project Scale	
Project	X
Large project	

Year	Estimated GHG emission reductions or removals (tCO ₂ e)
2012	95,883
2013	10,073
2014	0
2015	29,903
2016	53,460

² Supporting document [Start date]

Year	Estimated GHG emission reductions or removals (tCO ₂ e)
2017	90,488
2018	95,132
2019	122,854
2020	85,532
2021	0
2022	0
2023	0
2024	0
2025	0
2026	0
2027	0
2028	0
2029	0
2030	0
2031	0
2032	0
2033	0
2034	0
2035	0
2036	0
2037	0
2038	0
2039	0
2040	0
2041	0
2042	0
2043	0
2044	0
2045	0
2046	0
2047	0
2048	0
2049	0
Total estimated ERs	583,326
Total number of crediting years	36
Average annual ERs	16,203

1.8 Description of the Project Activity

The project activity will be quantified by the reduction of emissions because of planting *Tectona grandis*. The project owner has a management plan for each of the properties, which has been presented to the

Secretary of Environment and Natural Resources - SEMARNAT - to obtain legal registration of the plantation³.

The silvicultural activities that are carried out in the plantation are⁴:

Preparation of the land:

Areas with grassland vegetation and intermittent weeds will be plowed using a "chopper" tractor. Subsequently the following tasks will be done:

- Double drag step: This will be done to take out the land. It will consist of a double drag pass with the purpose of removing and conditioning the arable layer of soil and incorporating weeds and grasses. This will be carried out with crawler tractors and semi-heavy Agromex dredges.
- Preliminary outline: This activity will be carried out by a group of surveyors, a supervisor and 4 auxiliary staff, so they can indicate the rows where they are going to build the mounds to plant Teak.
- Tillage: This activity consists of using agricultural tractors to arrange the earth in the form of a border or planting rows to increase the thickness of the soil layer where the plant will be introduced.

Plant production:

The vegetative material needed for planting will come from the nursery owned by Agropecuaria Santa Genoveva, which is in the town of Pich, Campeche. The Teak seed is certified and comes from CATIE and Seeds and Forest Company⁵, which is in Turrialba, Costa Rica.

Type of packaging:

The packaging to be used is fixed tubes of 310, 220, 130 and 60 cc in platters and jiffy bags.

Physical and sanitary conditions of the plant:

The following are recommendations for plants to be used in this type of commercial afforestation program: they should be two-three months old, 25-35 cm tall with a lignified 1.0-1.5 cm diameter stem at the neck, 15 to 20 cm of roots with ramifications, and the aerial part should have a healthy foliage, with no signs of pests, diseases, nutritional deficiency nor weak branches.

Transport of the plants:

This activity refers to the transfer of the plants from the nursery to the planting site. The plants will be transported in trucks. They will be carried in plastic bins from where they were transported to the planting site. This system prevents damage to the plants and their root balls, so the plants arrive in a suitable condition.

Design and layout of the plantation:

3 See supporting folder [Non-permanence risk tool\Internal risk\Project management\Management plans] and [Non-permanence risk tool\External risk\Land Tenure]

4 Supporting document [Non-permanence risk tool\Internal risk\Project management\organization_chart] presents the people in charge of the project activities.

5 <http://www.semillasybosques.com/>

The plantation is established with a spacing between plants of 3.5 x 3.5 m, which gives a planting density of approximately 816 plants / ha. This density and layout of the plants allows the same area per plant, better management of the thinning, development and health of the trees.

Planting and replanting techniques:

The main activities are: a) digging a hole of sufficient size (10-20 cm depending on the size of the tubes) to introduce the root ball of the plant - this will be done using a wooden stake - b) planting the seedling and gently tapping the soil to avoid air pockets in the earth that can impair the grip of the plant's roots.

Preferably, planting should take place during the rainy season (May to September). Replanting will take place no later than a month after planting, so providing sufficient time to evaluate the mortality rate of the plants.

Fertilization:

This activity accelerates the growth rate of the seedlings once they have been planted, increasing the chances of survival and development by up to 98%. Fertilizers will be applied in the first three years. Doses of fertilizer depend on the tree age and soil characteristics.

Weed control:

Teak, in its early development, is very susceptible to competition from weeds, so the control of this competitive vegetation is essential. This must continue up until the plant reaches a sufficient height and has sufficient root development to overcome this competition for insolation and nutrients. Controls will be carried every year during the rainy season, after which time natural weed control will occur due to the shade that the planted trees will create.

The control of weeds will be done mainly mechanically, using agricultural tractors with veneers. If chemical control is used, a sprinkler driven by an agricultural tractor will be used, if the weeds cover an extensive area of the land. Backpack sprays will be used if the weeds are only present in localized areas. Mechanical equipment such as motor scooters, or hand tools, such as the machete, may also be used to combat weeds. Machetes are often used to clear space around each plant.

Pruning:

Programmed pruning is carried out during the first 3 years (low pruning), medium pruning is carried out depending on the growth characteristics of the plantation, and high pruning is used to improve the quality of the wood and the cleanliness of the shaft. Finally, pruning is carried out after thinning to eliminate epicormic buds that appear after thinning.

Thinning:

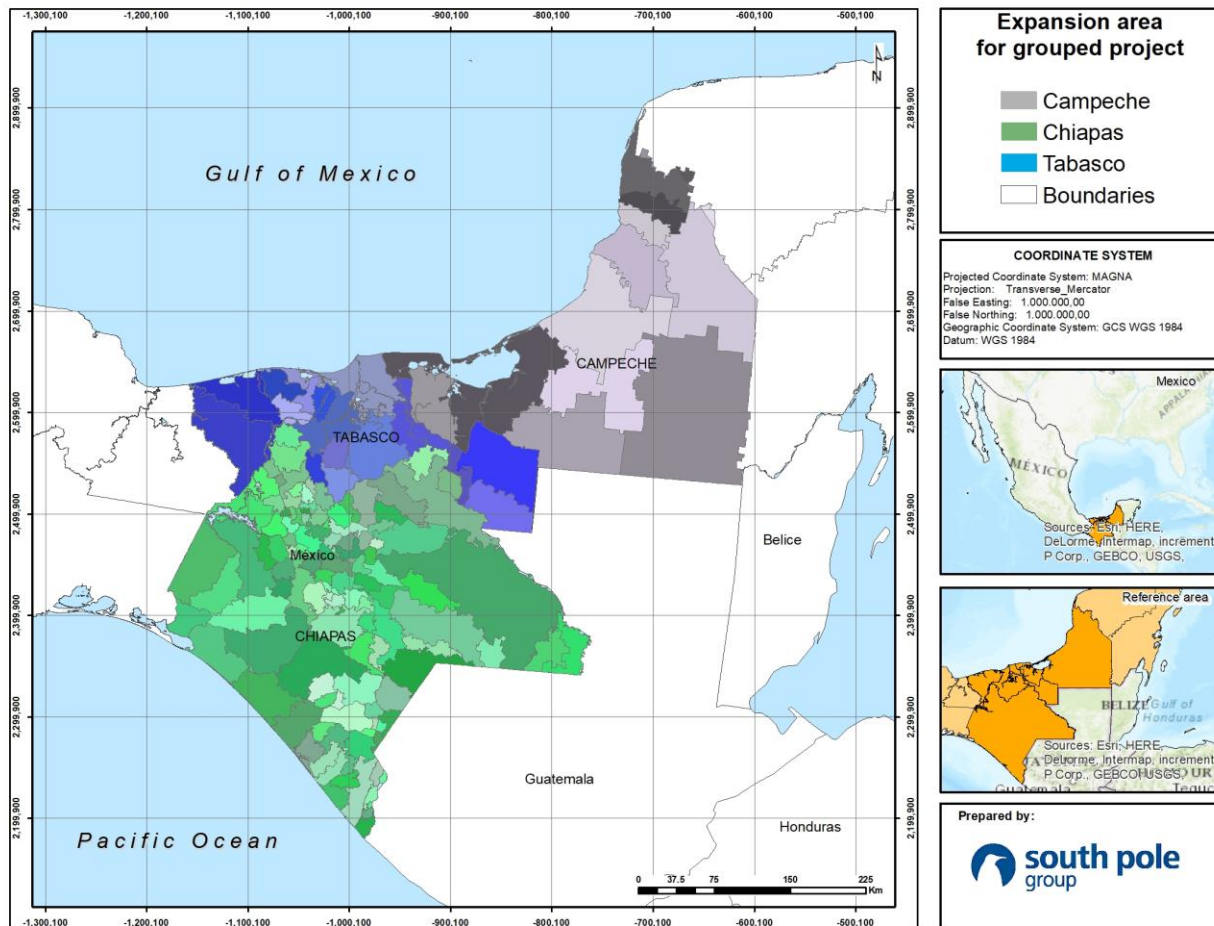
It is estimated that, in natural conditions, the soil has the capacity to sustain an average of 30 m²/ ha of basal area. To improve the growth of the trees in terms of mass and trunk diameter, different thinning activities will be carried out. For teak, this is planned to be done in years 4, 6 and 11. However, the age at time of pruning can vary, depending on the growth of the plant. The calendar and intensity of thinning is proposed as follows:

- In the first thinning, 14% of the 816 trees planted will be removed, leaving 701.76 trees in place.
- For the second thinning, of the 701.76 trees, 30% will be removed leaving 491.76 trees.
- And in the last thinning 45% of the 491.76 trees will be removed, leaving 270.47 trees for the final harvest (year 18). Depending the quality site may be less trees per hectare

1.9 Project Location

1.1.1 Location of the expansion area for the grouped project

The region of expansion of the grouped project covers the states of Tabasco, Chiapas and Campeche in the United States of Mexico (¡Error! No se encuentra el origen de la referencia.).



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1.1.2 Project area – first phase of the grouped project

The project area included during the first phase of the grouped project spans 4,011.96 ha, across 97 instances (properties) located in five municipalities: 16 properties in Balancán (Tabasco), 54 properties in Huimanguillo (Tabasco), 13 properties in Tenosique (Tabasco), 2 properties in Palenque (Chiapas), and 12 properties in Candelaria (State of Campeche). The location of the project area of the first phase of the grouped project is presented in the following link: <http://arcg.is/0eaje1>

1.10 Conditions Prior to Project Initiation

1.10.1 Expansion region

The following characteristics correspond to the states of Chiapas, Tabasco and Campeche, where the project is being implemented (**¡Error! No se encuentra el origen de la referencia.**).

Land use

The main land cover in Mexico are distributed as follows: 29.3% corresponds to shrubs and bushes, 15.5% to forest, 14.2% to pasture, 13.4% to jungle, 12.7% to agricultural land, 11.4% to forest farmland, 1.6% to desert and dune vegetation and 1.9% to other uses⁶. Agriculture is the main land use in the three states of the expansion region (Figure 1).

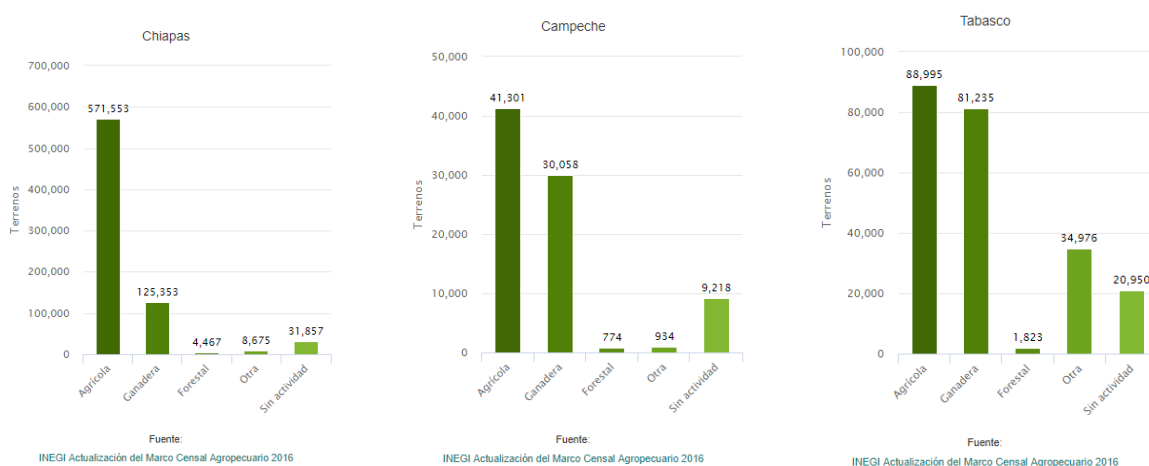


Figure 1: Land use in the states of the expansion region

Topography and soils

In accordance with the soil classifications of the United Nations Food and Agriculture Organization (FAO), the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the World Soil Information (ISRIC) (1988), one can establish 28 units or categories of soil, of which 25 are present in Mexico. The soil categories that occupy more than 10 million hectares at the national level are, in order of presence: leptosols (24% of the territory); regosols (19%); calcisols (18%); feozems (10%) and vertisols (8%). This composition reflects the dominance of shallow and young soils in Mexico.

In the following table the principal soil units found in the expansion area of the grouped project are presented:

Table 1. Soil units found in the expansion area

⁶ Vasquéz J. et al. (2009). Memoria del estudio Regional Forestal-Chiapas. 6/11/2017, de COLEGIO DE INGENIEROS AGRÓNOMOS DE CHIAPAS, A.C-CONAFOR. Disponible en: <http://www.conafor.gob.mx:8080/documentos/docs/9/3821Memoria%20del%20Estudio%20Regional%20Forestal%200704.pdf>

Soil unit	Description	Potential use	Federal entity where it is found
Leptosols	Very thin, stony and poorly developed soils with a large amount of calcareous material; they possess a reduced or thin thickness with the presence of fragmented rocks and around 10% fine soils (INEGI 2007).	These soils are not suitable for agriculture or livestock raising; rather, they prefer to be under forest cover ⁷ .	Campeche Tabasco
Vertisols	Soils that can be found in lake beds, on river banks or in sites which experience periodic flooding. They are characterised by their high content of clay, which makes them difficult to work because they become hard during dry times and very sticky in rain (IUSS, 2007). However, with good handling, they are very productive soils (INEGI 2007).	Soils with agricultural-forestry vocation, with higher long-term yields in the forestry sector ⁸ .	Campeche Tabasco
Regosols	Very young soils that develop on unconsolidated material, are of light colours and are poor in organic matter. They are found in all climates, with the exception of permafrost zones, and in all elevations, and are particularly common in arid, semi-arid (including dry topics) and mountainous regions, they have Little agricultural vocation, although their use depends on their depth, rock characteristics and fertility, so their yields are variable (FAO, 2001). Their use and handling vary widely.	Under irrigation, these soils support a wide variety of uses, although extensive low-load pastures are their main use. Having no irrigation is preferable under forests. ⁹	Campeche Tabasco Chiapas
Cambisols	They develop on alteration materials from a wide range of rocks. They present horizons with a weak to moderate alteration of the original material, due to the absence of appreciable quantities of clay, organic matter compounds of iron and aluminium, or material of alluvial origin. Its principal limitations are associated with topography, low thickness, rock characteristics or low base content. ¹⁰	Its use generally remains confined to forestry or fishery.	Tabasco
Fluvisols	The original material consists of deposits, predominantly recent, of fluvial, lake or marine origin. They are found in periodically flooded areas, like alluvial plains, river fans and swampy valleys.	They are often used for consumer crops, orchards and, frequently, for establishing livestock pastures.	Tabasco
Phaeozem	They are formed on unconsolidated material. They are found in temperate and humid climates	They are used intensively for the production of grains	Tabasco

7 Universidad de Extremadura (UNEX). (s/f). El suelo es un Leptosol. Disponible en: <https://www.eweb.unex.es/eweb/edafo/FAO/Leptosol.htm>

8 Universidad de Extremadura (UNEX). (s/f). El suelo es un Vertisol. 10/11/2017, de eweb Sitio web: <http://www.eweb.unex.es/eweb/edafo/FAO/Vertisol.htm>

9 Universidad de Extremadura (UNEX). (s/f). El suelo es un Regosol. Disponible en: <http://www.eweb.unex.es/eweb/edafo/FAO/Regosol.htm>

10 Universidad de Extremadura (UNEX). (s/f). El suelo Cambisol. Disponible en: <http://www.eweb.unex.es/eweb/edafo/FAO/Cambisol.htm>

Soil unit	Description	Potential use	Federal entity where it is found
	with the natural vegetation of high pastures or forests. They are dark soils and rich in organic matter, therefore they are widely used in agriculture. However, periodic droughts and wind and water erosion are its principal limitations.	(soybeans and wheat, for example) and vegetables, and as pastures (INEGI, 2017). They are of a forestry vocation (Abisai J. et al. 2004).	
Andosols	The original material is constituted mainly of volcanic ash, but may also appear <i>pumitas</i> , <i>lapillis</i> and other volcanic ejection products. They are found in hilly areas in humid regions, from the Arctic to the tropics, under a wide range of plant formations.	The majority of these soils are cultivated intensively with a great variety of plants.	Tabasco
Luvisols	These soils are found above a wide range of unconsolidated materials, such as alluvial terraces or glacial, wind, alluvial or colluvial deposits. They are one of the most fertile soils and so their use in agriculture is very high and covers, in general, the production of small grains, forages and sugar cane (INEGI, 2007).	When internal draining is adequate, these offer great potential for a large number of crops, including teak, because of its moderate state of alteration.	Chiapas
Gleysols	The original material is constituted of a wide range of unconsolidated materials, mainly sediment of fluvial, lake or marine origin from the Pleistocene or Holocene. In general, they are found in depressed or shallow landscape, with shallow groundwater mantles. Moisture is the main limitation of virgin Gleysols; they are usually covered with a swampy or useless natural vegetation or are used for extensive pastures.	Once drained, they can be used for cultivation, subsistence agriculture or orchards. In the tropics and subtropics they are widely used for rice cultivation. When well drained in a natural way, their vocational use is for livestock or forestry.	Chiapas

State of Chiapas¹¹

The state of Chiapas represents 3.7% of the land area of Mexico and is located between the geographic coordinates to the north 17°59'07", south 14°31'56" of north latitude; east 90°22'13 " , west 94°08'21" longitude.

Climate¹²

Chiapas is in the earth's intertropical strip, with the climate modified by variations in relief, resulting in warm, semi-warm, temperate and cold climates. The average temperature varies between 13.9 and 26.8°C¹³.

¹¹The general description of the state of Chiapas (mainly the topographic and hydrographic characteristics) was based on information from the National Institute for Federalism and Municipal Development, "Encyclopedia of Municipalities and Delegations of Mexico - Chiapas." Retrieved from: <http://www.inafed.gob.mx/work/enciclopedia/EMM07chiapas/>

¹²Part of the description of the climate was based on information from the National Institute of Statistics and Geography (INEGI) Government of the State of Chiapas, Statistical and Geographic Yearbook of Chiapas 2016. ISBN 978-607-739-961-2. Supporting document [Supporting documents/Literature/Anuario estadístico y geográfico de Chiapas 2016].

¹³ National Water Commission. Monthly Temperature Record in °C.

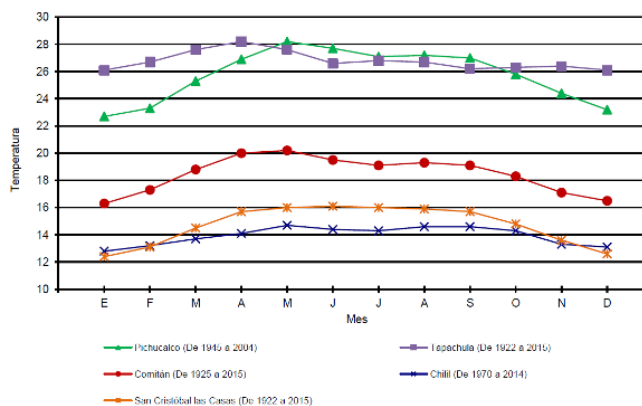


Figure 2: Average temperature (° C) per period in Chiapas¹⁴

In terms of humidity, there are areas with abundant rainfall throughout the year, as well as large areas with a rainy season (May-October) and a dry season (November-April). In the rainiest period, rainfall rises to between 2,091.6 and 5,672.2 mm per rainy season. The average annual precipitation varies between 827.3 and 4,011.5 mm¹⁵.

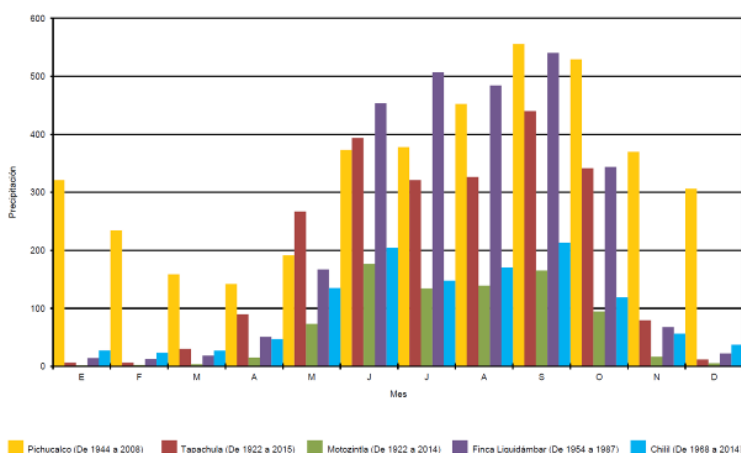


Figure 3: Average precipitation (mm) per period in Chiapas¹⁶

Hydrology

Hydrological resources are abundant, representing approximately 30% of the country's total resources. The area is divided into two slopes separated by the Sierra Madre: the Pacific slope, with short streams, is characterized by annual floods, and the Atlantic slope, which is drained by rivers with regular flow.

¹⁴ INEGI, National Institute of Statistics and Geography (2016). Statistical and geographical yearbook of Chiapas 2016. ISBN 978-607-739-961-2. Supporting document [Supporting documents/Literature/Anuario estadístico y geográfico de Chiapas 2016].

¹⁵ National Water Commission. Monthly rainfall record in mm

¹⁶ INEGI, National Institute of Statistics and Geography (2016). Statistical and geographical yearbook of Chiapas 2016. ISBN 978-607-739-961-2. Supporting document [Supporting documents/Literature/Anuario estadístico y geográfico de Chiapas 2016].

Ecosystems, biodiversity and vegetation

According to studies by CONABIO, in Chiapas, there are approximately 11,223 types of flora and fauna within its 73,211 km². There are 4,026 vascular plant species, 1,646 vertebrates, including 410 fish, 109 amphibians, 227 reptiles, 694 birds and 206 mammals. As such, Chiapas is the state with the highest number of bird species and the greatest diversity in terms of mammals. The number of recorded invertebrates is 4,109 species, of which around 1,252 species are butterflies. The diversity of butterfly species in Chiapas is equivalent to 62% of all butterfly species in Mexico and 6.5% in the world.

Evergreen tropical forests grow between 0 and 1,500 masl, a range in which it is viable to introduce *Tectona grandis*. Between 150 and 800 masl, forests of *Terminalia oblonga* thrive and *Virola guatemalensis* grows well with the following trees: *Aspidosperma Megalocarpon*, *Myroxylon balsamum*, *Vatairea lundellii*, *Attalea rostrata*, *Cambess*, *Ficus crassiuscula*, *Tetrorchidium rotundatum*, *Sterculia apetala* and *Tabebuia donnel-smithii*¹⁷.

State of Tabasco¹⁸

The state of Tabasco is in southeastern Mexico and stretches from the coastal plain of the Gulf of Mexico to the mountains of northern Chiapas, representing 1.3% of the country's territory. It can be delimited geographically to the north 18°39'03", to the south 17°15'03" of north latitude; east 90°59'15", west 94°07'48" west longitude.

Climate¹⁹

Tabasco is in a tropical zone, with its low elevation and 190 km Gulf of Mexico coastline resulting in a warm climate with maritime influence. The humid tropical climate with abundant rainfall in summer is unique to the region, with temperatures during the coldest part of the year standing between 22 and 26.3°C (January and December) and in the hottest period between 26.8 and 29°C. Average temperature ranges between 26.0 and 27.1°C²⁰, and the average precipitation varies between 1,567.2 and 3,437 mm²¹.

17 Miranda, F., 1952. The vegetation of Chiapas. First part. Editions of the State Government. Tuxtla Gutiérrez, Chiapas. 334 pp.

18 The general description of the state of Chiapas (mainly the topographic and hydrographic characteristics) was based on information from the National Institute of Statistics and Geography (INEGI) Government of the State of Tabasco, Tabasco 2016 statistical and geographical yearbook. ISBN 978-607-739- 971-1. Supporting document [Supporting documents/Literature/Anuario estadístico y geográfico de Tabasco 2016].

19 Part of the description of the climate was based on information from the National Institute for Federalism and Municipal Development, "Encyclopedia of Municipalities and Delegations of Mexico - Tabasco." Retrieved from: <http://www.inafed.gob.mx/work/enciclopedia/EMM27tabasco/index.html>

20. Average Monthly Temperature Record in °C.

21 National Water Commission. Part of the description of the climate was based on information from the National Institute for Federalism and Municipal Development, "Encyclopedia of Municipalities and Delegations of Mexico - Tabasco. Monthly record of rainfall in mm.

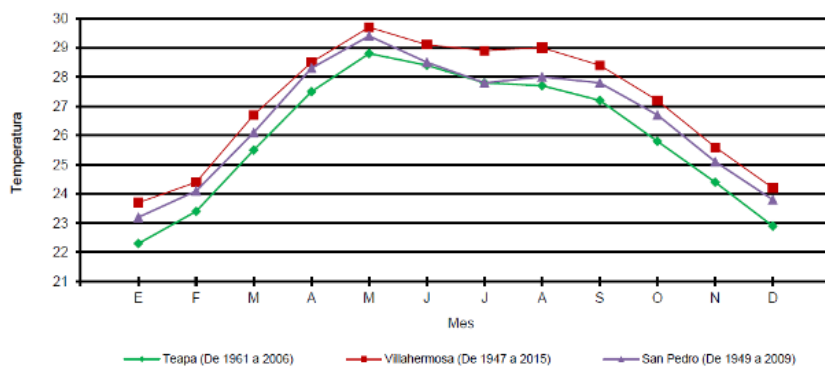


Figure 4: Average temperature (mm) per period in Tabasco²²

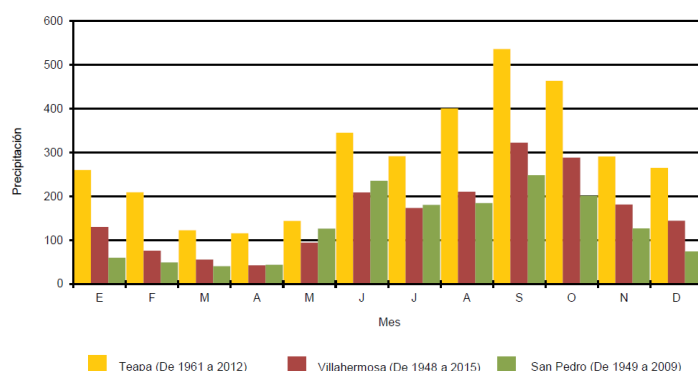


Figure 5: Average precipitation (mm) per period in Tabasco²²

Hydrology

The river system is made up of the Usumacinta river basin, which is the largest in the country, and the Grijalva river, which is the second largest, both of which have numerous tributaries which flow into the Gulf of Mexico. In addition to the numerous rivers, creeks and streams that flow in various directions throughout the state of Tabasco, there are also some lakes and many lagoons scattered across the territory. The lagoon system of El Carmen, Pajonal, La Machona and Mecoacán is particularly important.

Ecosystems, biodiversity and vegetation²²

The State of Tabasco's wildlife biodiversity ranks 1st in Mexico. This state has 45% of the bird species living in Mexico and 42% of flying mammal species. There are 820 wildlife species in the state, which can be broken down as follows: 113 mammals, 500 birds, 24 amphibians, 85 reptiles and 98 fish.

There are 70 mammals, 11 amphibians, 21 reptiles and 139 birds²³ that have conservation status. They have been given this status because they are likely to be extinct in the wild, are in danger of extinction, are threatened or need special protection.

²² *Idem* foot note 16

²³ CONAGUA-SEMARNAT. (2010). "Construction of clay board and control structures on the left bank of the usumacinta river, municipality of Tenosique, state of tabasco. Retrieved from <http://sinat.semarnat.gob.mx/dgiraDocs/documentos/tab/estudios/2010/27TA2010H0008.pdf>

According to Robert C West; Norbert P Psuty; B G Thom (1985)²⁴, in the state of Tabasco, the following different types of ecosystems and plant associations are found:

- *Rainforest*, covering most of the territory of Tabasco, with trees such as mahogany, cedar, macayo, corozo, ceiba, laurel, and willows, with shrubs and herbs such as capulin, popiste, ramoncillo and ferns. Various types of orchids and a type of cactus typical of the region can also be found.
- The *tropical savannah*, consisting of open land, extensive herbaceous and grassy fields dominate. This type of vegetation is abundant in the south of the state, and, in the plains where the rivers join, it is mixed with rainforest. Among the various trees and shrubs that can be found, there are round palm, long guano, jahuacte, sugar cane, anona, bamboo, paper tree, cocoyol, palm fasiste and palm brahea dulcís, encino, nance, tachicon, mimosas, cassias, jícaros, extensive grasslands, vines and creepers.

Public order

At present, Tabasco is going through a period of violence. It is perceived to be one of the most insecure areas at the national level, according to the results of the National Survey of Victimization and Perception of Public Safety (ENVIPE) 2017 carried out by the National Institute of Geography and Statistics (INEGI)²⁵.

According to the Citizen Institute for Studies of Insecurity (ICEI), Tabasco ranks highly for kidnapping. The state also has a particularly high rate of kidnapping of undocumented immigrants from Central America. Furthermore, it is becoming a distribution and recruitment center for several illegal industries, such as arms and drug trafficking²⁶.

State of Campeche²⁷

Campeche, 2.6% of the Mexican territory, is in the southwest of the Yucatan peninsula. It lies between the parallels 17°10' and 92°32' west of the Greenwich meridian.

Climate²⁸

91.74% of the state has a sub humid warm climate with rain in summer. Temperatures recorded in the coldest part of year (January and December) range between 21.4 and 25.3°C and between 26.6 and 28.8°C in the warmest period. The average temperature is between 24.1 and 27.1°C²⁹ (Figure 6).

²⁴ Robert C West; Norbert P Psuty; B G Thom (1985), The lowlands of Tabasco in southeastern Mexico, 3. ed. in. Villahermosa: Government of the State of Tabasco, Tabasco Institute of Culture.

²⁵ Tabasco Journal Hoy, "Insecure, 9 out of 10 Tabasco ". September 27, 2017. Retrieved from: <http://www.tabascohoy.com/nota/410423/inseguros-9-de-cada-10-tabasquenos>.

²⁶ La Verdad del Sureste Journal, "Tabasco is one of the states with a high rate of violence. " September 27, 2017. Retrieved from: <http://www.la-verdad.com.mx/tabasco-es-uno-los-estados-pais-con-alto-indice-violencia-27993.html>

²⁷ The general description of the state of Campeche (mainly the topographic and hydrographic characteristics) was based on information from the National Institute for Federalism and Municipal Development, "Encyclopedia of Municipalities and Delegations of Mexico - Campeche." Retrieved from: <http://www.inafed.gob.mx/work/enciclopedia/EMM04campeche/mediofisico.html>. Supporting document [Supporting documents/ Anuario estadístico y geográfico de Campeche 2016].

²⁸ National Institute of Statistics and Geography (INEGI) Government of the State of Campeche, Statistical and Geographic Yearbook of Campeche 2016.

²⁹ National Water Commission. Average Monthly Temperature Record in °C.

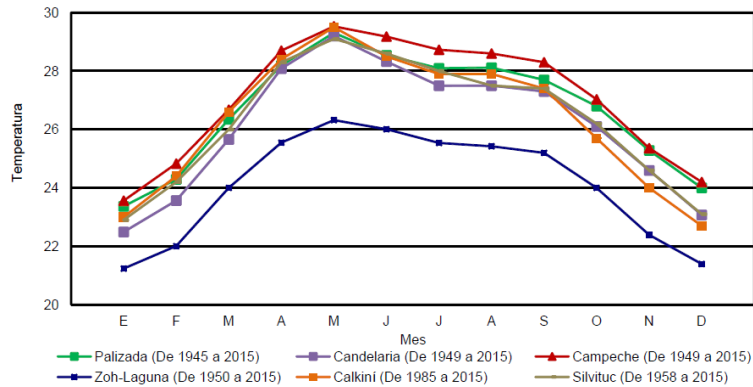


Figure 6: Average temperature (° C) per period in Campeche³⁰

The average precipitation varies between 998.5 and 1,904.5 mm ³¹ (Figure 7).

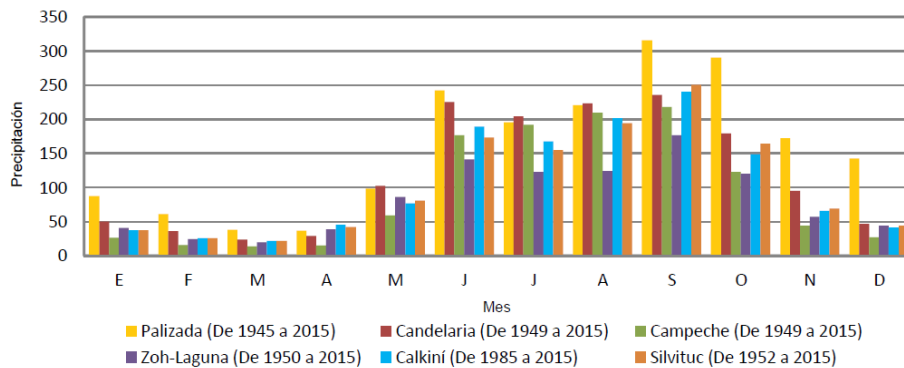


Figure 7: Average precipitation (mm) per period in Campeche³²

Hydrology

In the south and southwest of Campeche there are many rivers. The water bodies in this area are part of different basins. The largest is the Grijalva-Usumacinta system, followed by the Candelaria, Chumpán and Mamantel river basins.

Another important water feature is the formation of small lagoons that surround the Laguna de Términos, which together form part of the most important lagoon system in the country. From west to east, the lagoons are called Atasta, Pom, Puerto Rico, El este, Del Vapor, Del Corte, Pargos and Panlau.

³⁰ Part of the description of the climate was based on information from the National Institute of Statistics and Geography (INEGI) Government of the State of Campeche, Statistical and Geographic Yearbook of Campeche 2016. ISBN 978-607-739-977-3.

³¹ National Water Commission. Monthly rainfall record in mm.

³² Part of the description of the climate was based on information from the National Institute of Statistics and Geography (INEGI) Government of the State of Campeche, Statistical Yearbook. The general description of the state of Campeche (mainly the topographic and hydrographic characteristics) was based on information from the National Institute for Federalism and Municipal Development, "Encyclopedia of Municipalities and Delegations of Mexico - Campecheco and geographical zone of Campeche 2016. ISBN 978-607-739-977-3.

Ecosystems, biodiversity and vegetation³³

The types of vegetation found in the state of Campeche are low deciduous forest, medium sub-deciduous forest, medium subperennifolia forest, high perennifolia forest, low flood forest (low perennifolia), as well as mangrove, coastal dune vegetation and marine or seibadal pastures (sub-marine vegetation), petenes, tulari and savannas³⁴³⁵.

The predominant vegetation is medium forest, which occupies over 60% of the state's surface area. That said, in the southeast of the Calakmul Biosphere Reserve, which forms part of the Puuc-Chenes Biocultural Reserve, an important biological corridor exists. It consists of sub-deciduous jungle and low deciduous jungle that connects the median jungles of the center of the peninsula with the wetlands of western Yucatan and Campeche. There are also vegetation communities of high forest.

The genera of vascular plants that are endemic to this region, or are found there, are: *Asemnanthe*, *Beltrania*, *Goldmanella*, *Harleya* and *Plagiolophus*. The most common tree in the sub-tropical rainforest on the Yucatan Peninsula is *Vitex gaumeri*. In the northwest of Yucatán, *Vitex* and *Brosimum alicastrum* develops. *Bursera simaruba*, *Caesalpinia gaumeri*, *Lonchocarpus longistylus* and *Lysiloma latisiliquum* are also common.

Southeast Mexico has a complex geological history that has produced a lot of species of vertebrates; almost a third of the terrestrial mammals found in southeastern Mexico are endemic. The state of Campeche has a total of 4,379 species, including 15 aquatic mammals, 105 terrestrial mammals, 489 bird species and 99 reptiles³⁶. Additional to what is found in existing literature, the project proponent has done an inventory of the flora and fauna located in the state of Campeche (see as a supporting document³⁷).

1.10.2 Project area – first phase of the grouped project

The project area of the first phase of the grouped project consists of the area that is under control of the project proponent, until the validation process begins. The characteristics of the municipalities where the planted areas are located during the 2013-2017 period are described in Table 2³⁸.

33 Part of the description of the climate was based on information from the National Institute of Statistics and Geography (INEGI) Government of the State of Campeche, Statistical and Geographic Yearbook of Campeche 2016. ISBN 978-607-739-977-3.

34 Flores, J.S. e I. Espejel (1994). Types of vegetation of the Yucatan peninsula. Fascicle. No 3 Etnoflora Yucatanense. Mérida Yuc. Faculty of Veterinary Medicine and Animal Science. Autonomous University of Yucatan.

35 Barrera-Bassols, N., & Toledo, V. M. (2005). Ethnoecology of the Yucatec Maya: Symbolism, Knowledge and Management of Natural Resources. Journal of Latin American Geography, 4(1), 9–41. <https://doi.org/10.1353/lag.2005.0021>

36 Villalobos-Zapata y Mendoza-Vega. (2010). Biodiversity in Campeche: state study. Conabio.

37 [Supporting documents/Biodiversity_assessment]

38 More detailed information about the climatic conditions of these municipalities can be found as a supporting document in [Supporting documents/Weather information first instance] and about biodiversity conditions in [Supporting documents/Biodiversity_assessment]

Table 2: Characteristics of the municipalities included in the first instance.

State	Municipalities	Climate	Hydrological Region	Geomorphology and Topography	Dominant Soil	Vegetation	Land Use
Tabasco	Balancán ³⁹	Warm, humid with abundant rains in summer (69.70%) and warm, subhumid with rains in summer (30.30%). A temperature between 26 and 28°C, and precipitation between 1500 and 2500 mm (Figure 8 and Figure 9).	Grijalva - Usumacinta (100%).	Hill lands with plains (47.06%), alluvial plain with hill lands (24.20%), coastal floodplain (20.70%) and hillslope floodplain (8.04%). The municipality is between altitudes of below 100 m (Figure 31).	Gleysol (36.09%), Vertisol (30.02%), Cambisol (17.37%).	Rainforest (7.91%), forest (5.23%), tular (3.98%), induced pasture (1.09%) and savanna (0.10%).	Cultivated grassland (73.37%), agriculture (7.40%), urban area (0.18%) and cultivated forest (0.06%).
	Hiumanguillo ⁴⁰	Warm, humid with abundant rains in summer (60.03%) and warm, humid with rains throughout the year (39.97%). A temperature between 22 and 27 ° C, and precipitation between 2000 and 3500 mm (Figure 8 and Figure 9).	Coatzacoalcos (86.74%) and Grijalva Usumacinta (13.26%).	Typical hillock (37.82%), coastal flooded alluvial floodplain (33.09%), alluvial floodplain (21.04%), complex highland escarpment (4.12%), coastal alluvial plain (3.30%), plateau with gullies (0.47%), highland valley hillsides with dunes (0.15%) and coastal alluvial plain with dunes and salt (0.01%).	Gleysol (33.35%), Wet soils (16.89%), Vertisol (16.84%).	Rainforest (9.34%), tular (4.67%), savanna (4.48%), swamp ecosystem (popal in Spanish) (2.36%) and mangrove ecosystem (1.78%).	Agriculture (43.14%), cultivated pasture (32.46%), cultivated forest (0.35%) and urban area (0.49%).

39 Information extracted from the 2010 Municipal Geographic Information Compendium. Balancán, Tabasco. INEGI, National Institute of Statistics and Geography. Supporting document [Supporting Documents/Literature/Compendio Balancán - Tabasco].

40 Information extracted from the 2010 Municipal Geographic Information Compendium. Hiumanguillo, Tabasco. INEGI, National Institute of Statistics and Geography. Supporting document [Supporting Documents/Literature/Compendio Hiumanguillo - Tabasco].

State	Municipalities	Climate	Hydrological Region	Geomorphology and Topography	Dominant Soil	Vegetation	Land Use
				The municipality is between altitudes of below 100 m to more than 500 m (Figure 31).			
	Tenosique ⁴¹	Warm, humid with abundant rains in summer (79.17%) and warm, humid with rains throughout the year (20.83%). A temperature between 24 and 28°C, and precipitation between 1500 and 2500 mm (Figure 8 and Figure 9).	Grijalva – Usumacinta (100%)	Hill lands with plains (66.57%), folding lower mountains (22.17%) and valley slopes to be flooded (11.26%). The municipality lies between altitudes of below 100 m and up to 500 m (Figure 31).	Vertisol (28.05%), Leptosol (21.79%), Gleysol (21.44%).	Rainforest (23.23%) y tular (4.69%).	Cultivated grassland (63.17%), agriculture (7.01%) and urban area (0.57%).
Campeche	Calendaria ⁴²	Warm, subhumid with rain in summer, medium humidity (50.41%) and warm, subhumid with rain in summer, with higher humidity (49.59%). A temperature between 25 and 27°C, and precipitation between 1200 and 2000 mm	Grijalva - Usumacinta (99.64%) y Yucatán Oeste (0.36%).	Plain of lacustrine deposit of rocky or cemented floor (52.63%), coastal floodplain (30.45%), lower hill lands with plains (13.17%), hill lands with plains (2.98%), coastal alluvial plain (0.53%) and plain alluvial with hill lands (0.24%).	Vertisol (42.84%), Leptosol (29.48%), Phaeozem (15.08%).	Rainforest (64.07%), Tullar (3.71%), Forest (0.80%), Other (0.80%), and halophytic pasture (0.60%).	Ccultivated grassland (28.51%) and urban area (0.07%).

41 Information extracted from the 2010 Municipal Geographic Information Compendium. Tenosique, Tabasco. INEGI, National Institute of Statistics and Geography Supporting document [Supporting Documents/Literature/Compendio Tenosique - Tabasco].

42 Information extracted from the 2010 Municipal Geographic Information Compendium. Candelaria, Tabasco. INEGI, National Institute of Statistics and Geography. Supporting document [Supporting Documents/Literature/Compendio Candelaria - Campeche].

State	Municipalities	Climate	Hydrological Region	Geomorphology and Topography	Dominant Soil	Vegetation	Land Use
		(Figure 8 and Figure 9).		The municipality lies between altitudes of below 100 m and up to 300 m (Figure 31).			
Chiapas	Palenque ⁴³	Warm, humid with rains throughout the year (94.51%) and warm, humid with abundant rains in summer (5.49%). A temperature between 22 and 28 ° C, and precipitation between 2000 and 3000 mm (Figure 8 and Figure 9).	Grijalva – Usumacinta (100%)	Hill lands with plains (69.05%), high hillside mountains range (14.14%), folded lower mountains (10.34%), alluvial plain coastal floodplain (3.60%), high mountains range with glens (1.30%), high escarpment (1.28%) and low mountains (0.29%). The municipality is between altitudes of below 100 m to more than 500 m (Figure 31).	Leptosol (22.35%), Lluvisol (20.39%), Cambisol (15.93%).	Rainforest (38.87%), savanna (3.32%), tular (1.00%), induced grassland (0.28%) and forest (0.03%).	Pasture induced (54.99%), agriculture (0.22%) and urban area (0.62%).

⁴³ Information extracted from the 2010 Municipal Geographic Information Compendium. Palenque, Tabasco. INEGI, National Institute of Statistics and Geography. Supporting document [Supporting Documents/Literature/Compendio Palenque - Chiapas].

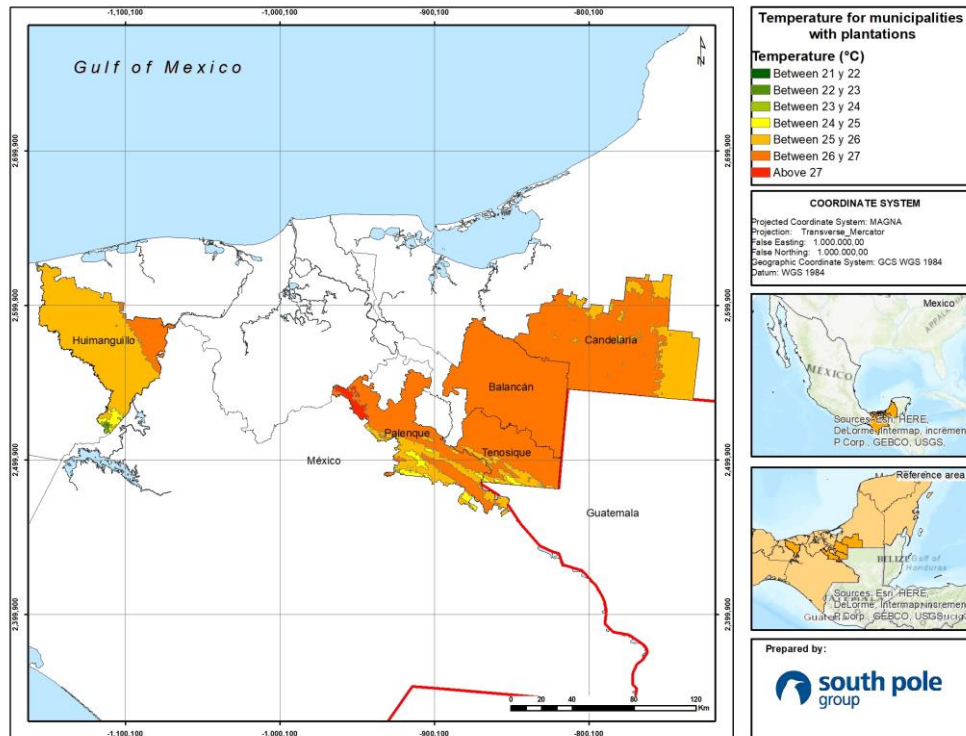


Figure 8: Average monthly temperature in the municipalities where the areas of the first instance are located.

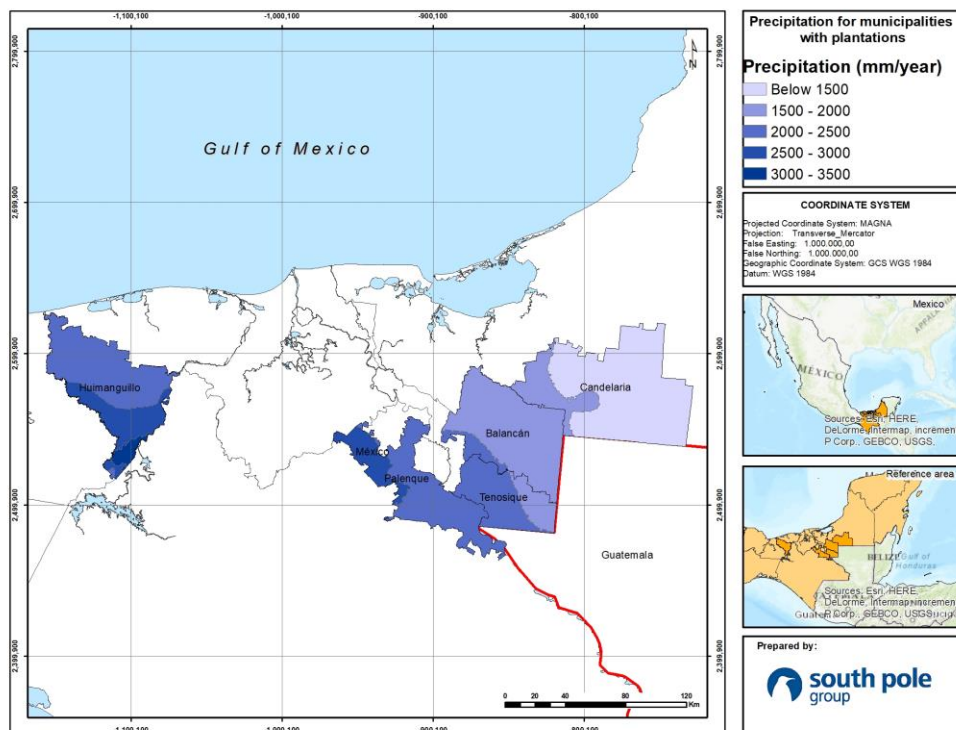


Figure 9: Average monthly precipitation in the municipalities where the areas of the first instance are located.

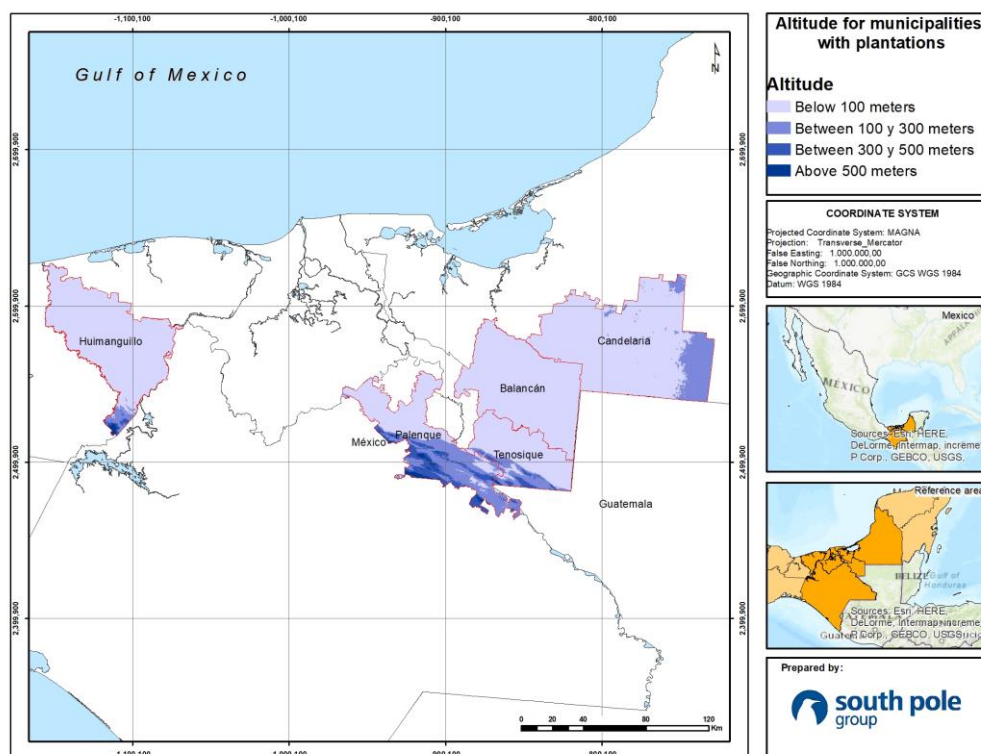


Figure 10: Elevation in the municipalities where the areas of the first instance are located.

1.11 Compliance with Laws, Statutes and Other Regulatory Frameworks⁴⁴

In Mexico, the principal regulation related to forestry projects is the General Law for Sustainable Forest Development - “Ley General del Desarrollo Forestal Sustentable”. The objective of this law is to regulate and promote the conservation, protection, restoration, management, cultivation and use of forest ecosystems and their resources in the country. The national institution in charge of the approval of the project activity is the Ministry of Environment and Natural Resources (SEMARNAT).

The document that demonstrates the project’s compliance with the General Law for Sustainable Forest Development is the registration of the plantation issued by SEMARNAT. All the properties included in the first phase of the grouped project have their registration approved⁴⁵.

In addition to the registration of the plantation, during the crediting period, the commercial forestry plantations of Agropecuaria Santa Genoveva comply with the legal framework established by the above-cited regulation:

⁴⁴ Information of the laws related to climate change is available as supporting document (Supporting documents/Legal framework).

⁴⁵ An example of the proof of registration can be found as supporting folder [Plantation registry_example]

- Applying to the appropriate authorities for the relevant permits to undertake project activities, including forestry permits and importing/exporting at customs.
- Altering the approved activity calendar or modifying the forest management program as required.
- Processing the authorization of commercial forest plantations for forestlands with an area greater than 800 hectares, along with their corresponding annexes.
- Presenting a report that includes the activities carried out (for the period January to December) on the execution of the management program of commercial forest plantations, during the first two months immediately following the year that is reported.
- Giving notice to SEMARNAT if it transpires that the provision of forestry technical services must be terminated, by means of a free written document, within the subsequent thirty business days.
- Demonstrating to the relevant authority the legal origins of forest products and raw materials.
- Requesting from the relevant authority the phytosanitary certification of imported raw materials or forest products. Commence work on forest sanitation and request support from the National Forestry Commission to carry out forest sanitation works. Present warnings when necessary regarding plagues or forest diseases.
- Demonstrating legal provenance when the competent authority requires it of the forest raw materials.
- Requesting that the authority authorize the operation of storage and processing centres for forest raw materials, including sawn and carved wood, as well as the modification of their data.
- Keeping a record book of entries and exits of forest raw materials, in written or digital form.

Additionally, the project receives economic support for its commercial teak plantations annually from the Public Forestry Policy of the Mexican Federal Government⁴⁶, which wants to promote the establishment and maintenance of commercial forest plantations to increase national forest productivity. This incentive is only received by plantations that comply with legal forestry regulations.

1.12 Ownership and Other Programs

1.12.1 Project Ownership

The properties involved in the project belong to Agropecuaria Santa Genoveva S.A.P.I. of C.V (AGSA). AGSA is part of a business group called AGRONEGOCIOS (Figure 11). However, the ownership and resource access or use rights are held by AGSA⁴⁷. Each plantation is registered under SEMARNAT, which assures that AGSA complies with land tenure⁴⁸. The Director of AGRONEGOCIOS is responsible for several companies that are independent from the legal, operational, and fiscal point of view. Each company has its own Federal Register of Taxpayers, and each company has its own accounting and source of financing. The other companies are small scale and do not have profits, so they are not a source of income that can support the AGSA forestry project, nor do they require financial support from AGSA, that is, they are independent.

⁴⁶ Federal Program: support for sustainable forestry development 2018 of the National Forestry Commission (CONAFOR)

⁴⁷ An example of the property documents can be found as supporting folder [Land tenure]

⁴⁸ Supporting Folder [Non-permanence risk tool/External risk/Land tenure/Plantation register].

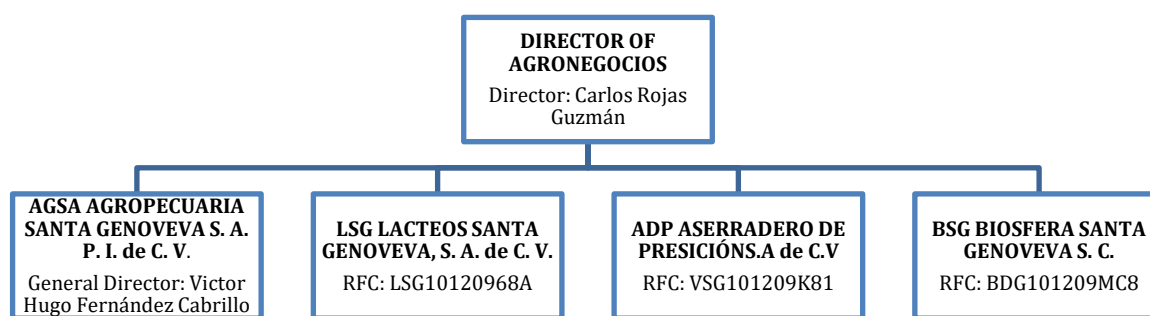


Figure 11. AGRONEGOCIOS organization chart showing its relationship with AGSA.

The evidence of project ownership for each project activity instance, held by AGSA from the respective start date of each project activity instance, is presented as a supporting document [Supporting documents\Land tenure\Properties titles]. All the properties were acquired before the establishment of the plantation. The document [Supporting documents\Land tenure\Proof of ownership\Proof of ownership\Relationship_acquisition_plantation year] presents the relationship between the year in which the plantation was established and the acquisition of the properties for the locations visited in the validation site-visit. In the folder [Supporting documents\Land tenure] the land titles of the properties visited are presented, and the property owner and year of acquisitions are highlighted in all the documents.

1.12.2 Emissions Trading Programs and Other Binding Limits

The emissions reduction or removal because of this project will not be used for compliance under any other trading program or mechanism. The current VCS project is entirely independent of any other carbon project scheme being developed in México, such as REDD+ projects; therefore, no double counting has or will occur.

1.12.3 Other Forms of Environmental Credit

The project has not sought nor received any other GHG environmental credit.

1.12.4 Participation under Other GHG Programs

The project has not been registered, nor is it seeking, registration under any other GHG program.

1.12.5 Projects Rejected by Other GHG Programs

No other GHG program has rejected the project.

1.13 Additional Information Relevant to the Project

Eligibility Criteria

An eligibility analysis has been developed considering all the eligibility criteria proposed by VCS to define the project area of the first instance. For the inclusion of any new eligible areas as instances willing to participate within the proposed grouped project, the new areas shall meet the following criteria:

- a) Be within one of the designated geographic areas specified in the project description (section 1.1.1);
- b) Comply with the following eligibility criteria:
 - 1. All areas to be incorporated into the grouped project must meet the applicability conditions set out in the methodology applied to the project:
 - a. No evidence of forest in the project area at the beginning of the reforestation activities⁴⁹. This criterion will be proven by ground-truthing, satellite images, aerial photographs, official maps or land-use records (as presented in subsection below);
 - b. The land cannot be categorised as wetlands;
 - 2. The project activity should be under the control of the project participants;
 - 3. Are subject to the baseline scenario determined in the project description for the specified project activity (reforestation);
 - 4. The new instances shall have characteristics with respect to additionality that are consistent with the initial instance for the specified project activity and geographic area.
- c) Be included in the monitoring report with the sufficient information (technical and geographic) in compliance with the eligibility criteria;
- d) Be validated at the time of verification against the eligibility criteria described in point b.
- e) Have evidence of project ownership, in respect of each project activity instance, held by the project proponent from the respective start date of each project activity instance.
- f) Have a start date that is the same, as or later than, the grouped project start date.
- g) Be eligible for crediting from the start date of the instance through to the end of the project crediting period (only). Note that where a new project activity instance starts in a previous verification period, no credit may be claimed for GHG emission reductions or removals generated during a previous verification period and new instances are eligible for crediting from the start of the next verification period.

Analysis of forest/non-forest for the period 2002 – 2012

Methodology

For an area to be considered eligible, and thus included in the project area, it must not meet the definition of forest⁵⁰ for a minimum period of 10 years prior to the start of the project. To verify this requirement, a historical forest cover search and analysis was carried out using the information from the Global Forest Change 2000-2016.

⁴⁹ Definition of forest for the country.

⁵⁰ Definition of Mexico's forest according to the Clean Development Mechanism (CDM): defines the forest as a minimum continuous area of 1 hectare, with a crown cover greater than 30% and a minimum potential in situ height of 4 meters. Available in: <https://cdm.unfccc.int/DNA/index.html>;

Global Forest Change 2000-2016 is a global loss and gain forest coverage map for the period 2000 to 2016, constructed by the University of Maryland⁵¹ Department of Geographic Sciences, based on Landsat TM, ETM +, and OLI images with a size of pixel of 30 m representing a scale of 1: 100,000.

The results of the map are a temporal series of Landsat images that characterize the forest cover and the change that occurred according to the following criteria:

- Forest cover: Trees with a minimum height of 5 m, expressed as percentage of crown density per cell for the year 2000.
- Loss of forest cover: An alteration or change from forest to non-forest, during the period 2000-2016.
- Annual loss of forest cover: The loss of forest area per year, from 2000 to 2016.
- Data mask: The values of this shape show the areas of land (continental) and bodies of water.

To perform the eligibility analysis, Global Forest Change⁵² information was downloaded and divided into 10 x 10 cells ranging from 180W-180E to 80N-60S. The project area is located between cells 20N - 90W and 20N - 100W. Four raster layers were downloaded. The first contains forest cover information at the pixel level (0% to 100%) for the year 2000, and was taken to 2002 by discounting deforested areas (second raster layer of annual forest cover loss-Hansen). The third layer contains information about the loss of forest cover up to 2016, which was used to obtain the forest/non-forest area for the year 2012. The fourth layer is the data mask (bodies of water). This information was used to intersect the forest/non-forest areas of 2002 and 2012 as these areas are not eligible.

With the raster information we proceeded to perform a post processing that consisted of:

- Changing the projection system of the WGS84 geographic coordinate system to the flat WGS84-UTM 21S (ArcGis software Project operation).
- Trimming the forest cover layer with the boundaries of the project area (ArcGis software Clip operation).
- Transforming the resulting layer (raster) to a vector format.
- The table of attributes of the vector (shape) was organized into the following categories:
 - o Category description: forest (1) and not forest (1) - based on the definition of forest of Mexico.
 - o Eligible category: Eligible (1) and Ineligible (0) - the eligible area is the area that remained without forest cover in 2002 and 2012 and which does not correspond to water bodies.
- Lastly, a clip was made with the lots reforested and the eligible areas were calculated.

Results:

Areas that are eligible for a carbon project according to the analysis described above are presented in Table 3. A map of the eligible areas planted in the period 2013-2017 is available online and can be accessed using the following link⁵³: <http://arcg.is/0eaje1>
<http://arcg.is/2hda89g>

⁵¹ For additional information about these results, see: <http://www.sciencemag.org/content/342/6160/850>; visited December 09, 2016.

⁵² Global Forest change. Available in: http://earthenginepartners.appspot.com/science-2013-global-forest/download_v1.2.html

⁵³ Maps are not displayed in the document because the scale of the map is 1: 2,000,000.

Table 3: Eligibility of the first instance⁵⁴

Strata	Year of establishment	Eligible Area (ha)
1.1	2013	424.14
1.2	2014	125.02
1.3	2016	591.27
1.4	2017	163.21
2.1	2014	1052.15
2.2	2015	1145.84
3.1	2013	377.72
3.2	2014	26.92
3.3	2017	105.69
Total		4011.97

Leakage Management

There is no leakage management in the project area.

Commercially Sensitive Information

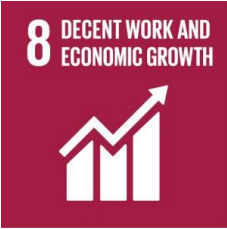
No sensitive information has been generated nor excluded from the public version of the project.

Sustainable Development

Given its expected outcomes, the project will contribute to the following sustainable development goals:

	The project provides new opportunities for formal employment in the region, contributing to an improved quality of life for the population. Currently, AGSA provides 424 permanent jobs, thus promoting regional economic growth. Approximately 90% of the workers are from the State of Campeche, Tabasco and Chiapas, and the majority of workers are hired from the towns surrounding the plantation facilities.
	New employment opportunities allow the community to have economic security and a greater ability to purchase food.
	The project provides job opportunities for women.

⁵⁴ See section 3.4 for strata definition.

	In the region, informal work is a common pattern, led by the state of Chiapas with 78%, followed by the state of Tabasco with 67.2% and finally by the state of Campeche with 64.3%, exceeding the national average. Workers generally work under high-risk conditions in terms of occupational safety⁵⁵. In the region, people are often hired without being offered social security (IMSS) or a lasting job, something which is reflected in the statistics provided by the Ministry of Labor and Social Security (2017) ⁵⁶, where the percentage of workers assigned to the Institute Mexican Social Security (IMSS) in the state of Chiapas is only 26.1%, in the state of Tabasco 27.2% and in the state of Campeche 49.3%. Therefore, if there was workplace accident, in general, the worker is further affected because he must assume financial responsibility for his medical costs and missed days of work. Currently, AGSA provides 424 permanent jobs with all benefits, thus promoting regional economic growth. Staff are granted the following additional benefits to those established in the Federal Labor Law (LFT), such as: loans for workers; recreational activities, financial support⁵⁷, life insurance and rewards for time spent at company.
	The project promotes the sustainable development of its value chain. Proof of this is the monitoring of FSC requirements in the implementation of forestry activities. In addition to this, AGSA is the first company in the agricultural sector in Mexico to obtain the Environmental Compliance Certificate granted by the Ministry of Environment and Natural Resources (SEMARNAT) through the Federal Environmental Protection Agency (PROFEPA) for the Forest Management of Forest Plantations.
	The project is concerned with the sustainable development of its activities and its contribution to the mitigation of climate change. The project area of the first instance has the potential to reduce 1,619,592 tCO₂e of GHG emissions over 36 years.
	PROFEPA granted AGSA/the PO an environmental certification in 2013 for Forest Conservation of Natural Areas. Currently, PROFEPA is in the process of re-certifying this project, giving recognition to its continued conservation commitments⁵⁸.

55 STPS. (2017). Tabasco, Labor Information. STPS. Retrieved from [http://www.stps.gob.mx/gobmx/estadisticas/pdf/perfiles/perfil tabasco.pdf](http://www.stps.gob.mx/gobmx/estadisticas/pdf/perfiles/perfil%20tabasco.pdf)

56 STPS. (2017). Tabasco, Labor Information. STPS. Retrieved from [http://www.stps.gob.mx/gobmx/estadisticas/pdf/perfiles/perfil tabasco.pdf](http://www.stps.gob.mx/gobmx/estadisticas/pdf/perfiles/perfil%20tabasco.pdf)

57 Example: two days with salary and payment for the birth of legally recognized children; two days with salary enjoyment and civil marriage payment; two days with salary enjoyment and payment for the death of a first-degree relative.

58 Proof of certification is presented as supporting document [Supporting documents\PROFEPA certification].

Further Information

There is no further information.

2 APPLICATION OF METHODOLOGY

2.1 Title and Reference of Methodology

AR-ACM003. Afforestation and reforestation of lands except wetlands. Version 2.0⁵⁹

Applied tools⁶⁰:

The applied tools are the following:

- “Combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities Version 01”;
- “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities Version 04.2”;
- “Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities Version 03.1”;
- “Estimation of non-CO2 greenhouse gas (GHG) emissions resulting from burning of biomass attributable to an A/R CDM project activity Version 04.0.0”;
- “Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity Version 02.0”.

2.2 Applicability of Methodology

Applicability condition AR-ACM0003	Project compliance
a. <i>The land subject to the project activity is not categorized as ‘wetland’</i>	Areas of wetland are not suitable for the planting of <i>Tectona grandis</i> . There are no wetlands in the project area. Low-lying lands that experience temporary flooding were left as reserve areas.
b. <i>Soil disturbance attributable to the project activity does not cover more than 10% of area in each of the following types of land, when the land is included within the project boundary:</i> - <i>Land containing organic soils;</i> - <i>Land which, in the baseline, is subject to land-use and</i>	The soils in the project area had less than 1% of organic matter before the project started. Much of the project area consists of extensive cattle ranching with little management. The areas planted in Huimanguillo, a municipality in Tabasco, were planted in areas of old citrus plantations (over 20 years old). According to Appendix 1. of the AR-ACM0003 methodology, only the tropical montane region has a

59 This methodology is available online at: <<http://cdm.unfccc.int/reference/index.html>>.

60 These documents are available online at: <<http://cdm.unfccc.int/Reference/index.html>>.

Applicability condition AR-ACM0003	Project compliance
<i>management practices and receive inputs listed in appendices 1 and 2 of the AR-ACM003 methodology.</i>	baseline management restriction for long-term cultivated cropland. Huimanguillo is located in the tropical wet region (Figure 12).
<i>A project activity applying this methodology shall also comply with the applicability conditions of the tools contained within the methodology and applied by the project activity.</i>	All the A/R methodological tools referenced by the methodology were applied (section 2.1).

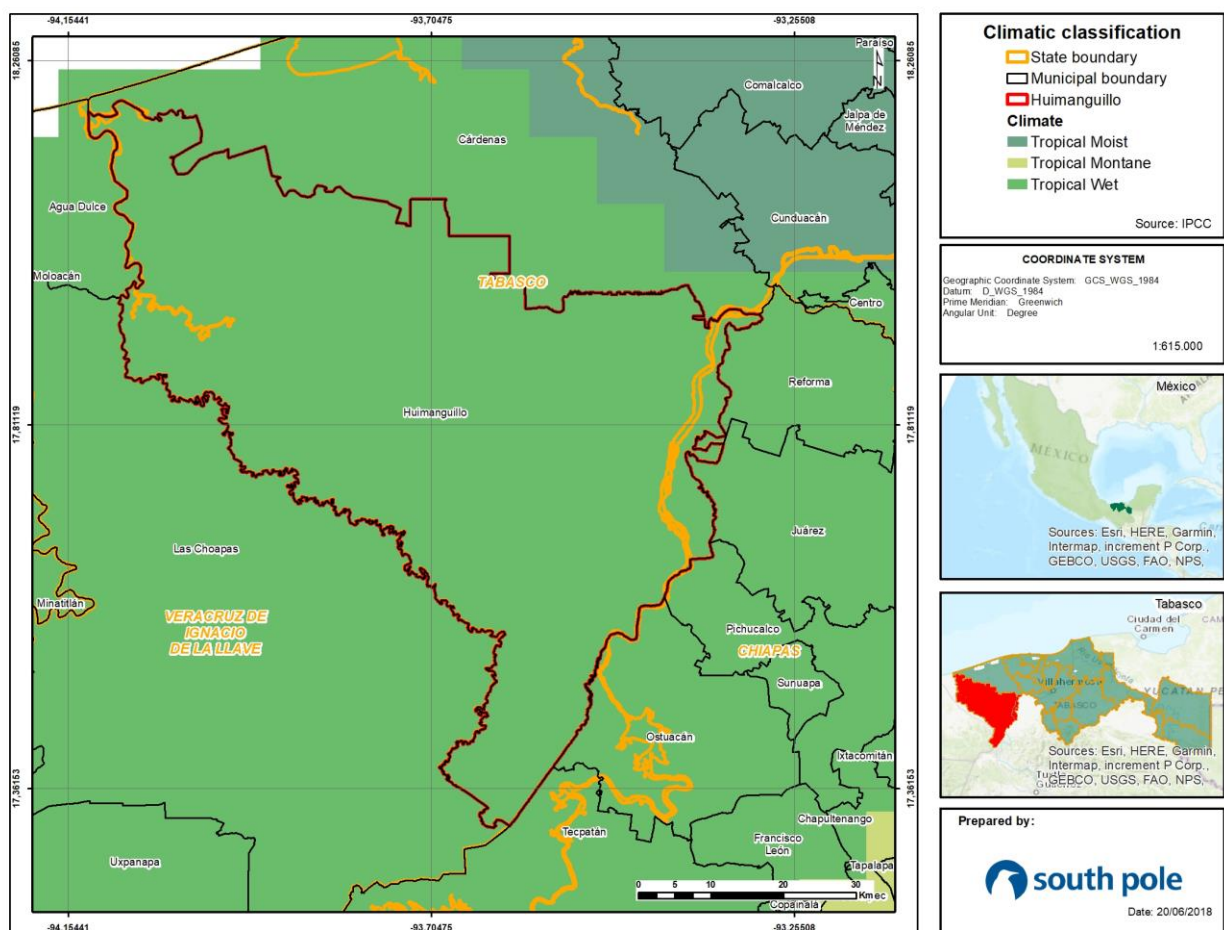


Figure 12: Climatic classification of Huimanguillo⁶¹

⁶¹ Climatic classification IPCC 2006 shapefile was download from: <https://esdac.jrc.ec.europa.eu/projects/renewable-energy-directive>.

Combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities	Project compliance
<i>Forestation of the land within the proposed project boundary performed with or without being registered as the A/R CDM project activity shall not lead to violation of any applicable law, even if the law is not enforced.</i>	The project complies with all applicable laws (Section 1.11).
<i>This tool is not applicable to small - scale afforestation and reforestation project activities.</i>	The project is not a small-scale project.

Estimation of non-CO₂ GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity	Project compliance
<i>The tool is applicable to all occurrences of fire within the project boundary.</i>	Project lifetime will not consider activities such as burning of harvest residue and use of fire to prepare the land. The tool will be applicable in future monitoring reports, when an occurrence of fire in the project area is reported.
<i>Non-CO₂ GHG emissions resulting from any occurrence of fire within the project boundary shall be accounted for each incidence of fire which affects an area greater than the minimum threshold area reported by the host party for the purpose of defining forest, provided that the accumulated area affected by such fires in a given year is ≥5% of the project area.</i>	Any occurrence of fires will be included in the monitoring report.

Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities	Project compliance
<i>This tool has no internal applicability conditions.</i>	NA
<i>The default-factor based method is applicable only if dead wood remains in situ and is not removed from the project boundary through any type of anthropogenic activities.</i>	Dead wood is not removed from the project boundary.
<i>The default-factor based method is applicable only if litter remains in situ and is not removed from the project boundary through any type of anthropogenic activities.</i>	Litter is not removed from the project boundary.

Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities	Project compliance
<i>This tool has no internal applicability conditions.</i>	NA

Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity	Project compliance
<i>This tool is not applicable if the displacement of agricultural activities is expected to cause, directly or indirectly, any drainage of wetlands or peat lands.</i>	NA - The project activity is not involved with a Wetland Restoration and Conservation project.

Conditions from the Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities	Project compliance
<i>This tool is applicable when the areas of land, the baseline scenario, and the project activity meet the following conditions:</i> <i>(a) The areas of land to which this tool is applied:</i> <i>(i) Do not fall into wetland category; or</i> <i>(ii) Do not contain organic soils as defined in Annex A: Glossary of the IPCC GPG LULUCF 2003;</i> <i>(iii) Are not subject to any of the land management practices and application of inputs as listed in the Tables 1 and 2 of the tool.</i> <i>(b) The A/R CDM project activity meets the following conditions:</i> <i>(i) Litter remains on site and is not removed in the A/R CDM project activity; and</i> <i>(ii) Soil disturbance attributable to the A/R CDM project activity, if any, is:</i> <i>- In accordance with appropriate soil conservation practices, e.g. follows the land contours;</i>	The project has not defined its establishment practices for the second round. However, soil disturbance due to the removal of stumps is expected. Therefore, soil capture as a compartment was not included for this analysis.

Conditions from the Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities	Project compliance
- <i>Limited soil disturbance for site preparation before planting and such disturbance is not repeated within twenty years.</i>	

2.3 Project Boundary

Table 4 and Table 5 show the relevant carbon pools and GHG sources for the project and baseline scenario:

Table 4: Selection and justification of carbon pools

Carbon pools		Selected?	Justification/Explanation
Baseline and Project scenario	Above-ground biomass	Yes	This is the major carbon pool subjected to project activity.
	Below-ground biomass	Yes	Carbon stock in this pool is expected to increase due to the implementation of the project activity.
	Dead wood Litter and	Yes	Carbon stock in these pools may increase due to implementation of the project activity.
	Soil organic carbon	Excluded	Carbon stock in these pools may not increase due to implementation of the project activity.

Table 5: Selection and justification of carbon pools and GHG sources

Source		Gas	Included?	Justification/Explanation
Baseline	Burning of woody biomass	CO ₂	Excluded	Potential emissions are negligibly small as there is no burning of woody biomass.
		CH ₄	Excluded	Potential emissions are negligibly small as there is no burning of woody biomass.
		N ₂ O	Excluded	Potential emissions are negligibly small as there is no burning of woody biomass.

Source		Gas	Included?	Justification/Explanation
Project	Burning of woody biomass	CO ₂	Excluded	Potential emissions are negligibly small as there is no burning of woody biomass.
		CH ₄	Excluded	Potential emissions are negligibly small as there is no burning of woody biomass.
		N ₂ O	Excluded	Potential emissions are negligibly small as there is no burning of woody biomass.

2.4 Baseline Scenario

The potential baseline scenario for the project area of the first instance is extensive livestock farming. The analysis presented in section 2.5 demonstrates why this scenario is the most likely, considering the reality of the expansion area of the grouped project. However, section 3.1 'Baseline emissions' was undertaken taking into account the existence of two scenarios: extensive livestock farming (Figure 13) and citrus crop plantations with an age of approximately 30 years (Figure 14)⁶². The location of the citrus plantation is presented in Figure 15.



Figure 13: Extensive livestock farming in the project area previous Teak establishment

⁶² The number of project instances with citrus plantation before the project starting date is 54.



Figure 14: Citrus crop cultivation in areas close to the project

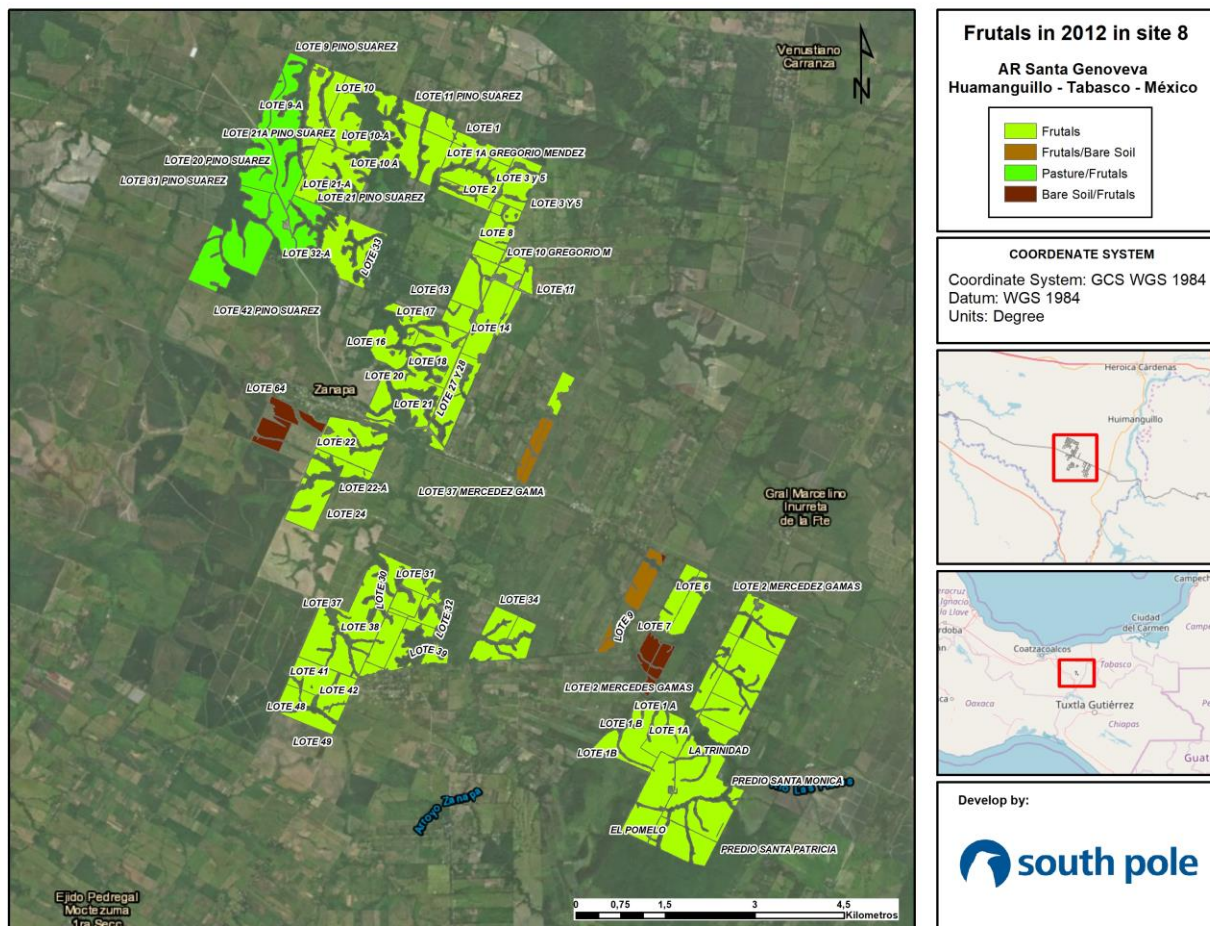


Figure 15: Location of the project instances with citrus plantation before the project starting date

2.5 Additionality

Additionality was calculated by following a methodological tool to measure the baseline scenario and demonstrate the additionality in AR CDM project activities. The following steps were developed to demonstrate additionality:

- STEP 1. Identification of alternative land use scenarios to the AFOLU project activity;
- STEP 2. Barrier analysis or;
- STEP 3. Investment analysis;
- STEP 4. Common practice analysis.

2.5.1 Step 1. Identification of alternative scenarios

Sub-step 1a. Identify credible alternative land use scenarios to the proposed project activity

Alternative 1: Agriculture

Land used for agriculture and pasture has increased over time in Mexico. By 1993, this type of anthropic coverage had increased by 6.5 million ha to cover a total area of 46.8 million ha. This increase happened at a rate of 380,000 ha per year. By 2002, the area dedicated to agriculture and grasslands for livestock had also increased by almost 3 million ha to reach a total area of 49.8 million ha⁶³. According to the Agricultural Census Framework 2016⁶⁴, the total area of agricultural activities reached 49.9 million ha (94.6% of which is open-air agriculture) in about 6.5 million productive units across the country. Because of this, Mexico has established itself as one of the main producers and exporters of food in the world, positioning the agri-food sector as one of the main engines of the national economy.

Table 6: Surface dedicated to open-air agricultural production by federative entity in the reference area of the project⁶⁵.

Federative entity	Land mainly with agricultural activity	
	Productive units	Area (km ²)
National	6,229,536	472,730.18
Campeche	40,477	19,009.89
Chiapas	125,247	35,985.66
Tabasco	86,628	4,027.10

63 National System of Environmental Information and Natural Resources. (2008). Report on the environmental situation Mexico. Retrieved from http://apps1.semarnat.gob.mx/dgeia/informe_2008/index_informe_2008.html.

64 Update of the Agricultural Census Frame 2016. National Institute of Statistics and Geography (INEGI). Retrieved from <http://www.beta.inegi.org.mx/proyectos/agro/amca/>.

65 Source: Update on the Agricultural Census Framework (2016) - National Institute of Statistics and Geography (INEGI).

Tabasco has tropical agriculture and contributes to the international market through the production and exportation of plantain, sugar cane, cocoa, pineapple and citrus. In 2016, about 86,628 properties, which cover an area of 4,027 km², had agriculture as their main activity (17.2% of the area of the state)⁶⁶. Given the soil and climate conditions, Tabasco is one of the states in the southeast of Mexico that has the potential to progress further in agriculture. The agricultural economy is, simply put, based on three crops, which represent about 65% of the total value of production. They are as follows: cocoa (32%), corn (18%) and sugar cane (15%)⁶⁷.

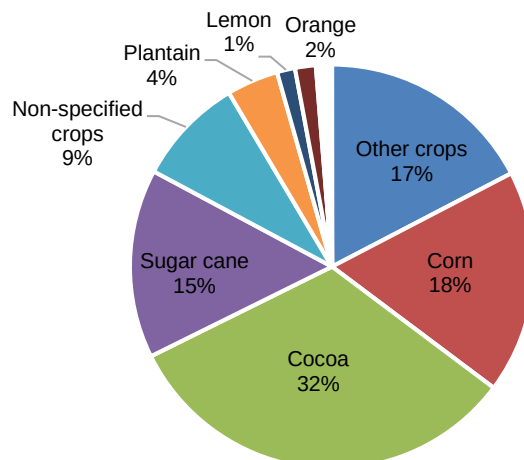


Figure 16: Areas dedicated to open-pit agricultural production, based on estimated planted area and main crops in the state of Tabasco⁶⁸.

In Chiapas, the area used for agricultural activity is 35,986 km² and is distributed over approximately 125,247 properties. According to information from the Agricultural Census Framework 2016, the most prominent products within the state are corn, (approximately 10,360 km² and 6.3% of the country's production), oats, (3,217 km²), la alfalfa (2,889 km²), cotton (2,324 km²) and beans (1,643 km²)⁶⁹. Other important products are palm oil, which Chiapas produces more of than any other state in a 59,000-ha area, and coffee, with a planted area of 253,764 ha representing 35% of the national total. Additionally, at a national level, Chiapas is an important supplier of grains. To strengthen the agricultural market, schemes, agricultural agreements and different agricultural credit lines have been created to promote agricultural and

66 Update of the Agricultural Census Framework 2016. National Institute of Statistics and Geography (INEGI). Retrieved from <http://www.beta.inegi.org.mx/proyectos/agro/amca/>.

67 Government of the State of Tabasco. Sectoral Program for Agricultural, Fishing and Food Development 2013-2018. Retrieved from https://www.gob.mx/fnd/documentos/programa-sectorial-de-desarrollo-agropecuario-pesquero-y-alimentario-2013-2018_dof.

68 Source: Update on the Agricultural Census Framework (2016) - National Institute of Statistics and Geography (INEGI).

69 Update of the Agricultural Census Frame 2016. National Institute of Statistics and Geography (INEGI). Retrieved from <http://www.beta.inegi.org.mx/proyectos/agro/amca/>.

livestock activities. Chiapas contributes approximately 2% of the total volume of national agricultural production⁷⁰.

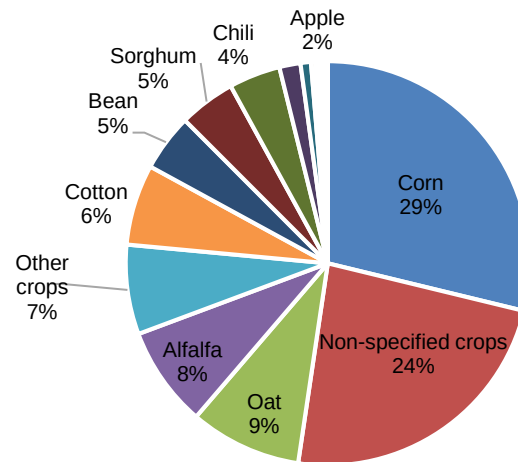


Figure 17: Areas dedicated to open-pit agricultural production according to estimated planted area and main crop in the state of Chiapas ⁷¹.

In the state of Campeche, about 32.8% of its total area is devoted to agriculture (19,010 km² distributed over 40,477 properties). 72.6% of the existing production units have agriculture as the main economic activity⁷². The most cultivated product is corn, with about 12,000 km² dedicated to its production in 2016 in over 26,000 production units. Other key products are soybean (2,458 km²), sugar cane (578 km²), pumpkin (475 km²) and sorghum (217 km²) ⁷³.

⁷⁰ Government of the State of Chiapas. Sectorial Program for Sustainable Rural Development. Retrieved from <http://www.planeacion.chiapas.gob.mx/progranasectoriales/Programa%20Sectorial%20de%20Desarrollo%20Rural%20Sustentable%202013-2018.pdf>.

⁷¹ Source: Update on the Agricultural Census Framework (2016) - National Institute of Statistics and Geography (INEGI).

⁷² Update of the Agricultural Census Framework 2016. National Institute of Statistics and Geography (INEGI). Retrieved from <http://www.beta.inegi.org.mx/proyectos/agro/amca/>.

⁷³ Sectorial Diagnosis for Planning in the State of Campeche. Government of the State of Campeche, Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA) and National Institute of Forestry, Agriculture and Livestock Research (INIFAP). Retrieved from <http://www.sagarpa.gob.mx/Delegaciones/campeche/PublishingImages/Diagnostico%20Sectorial.pdf>.

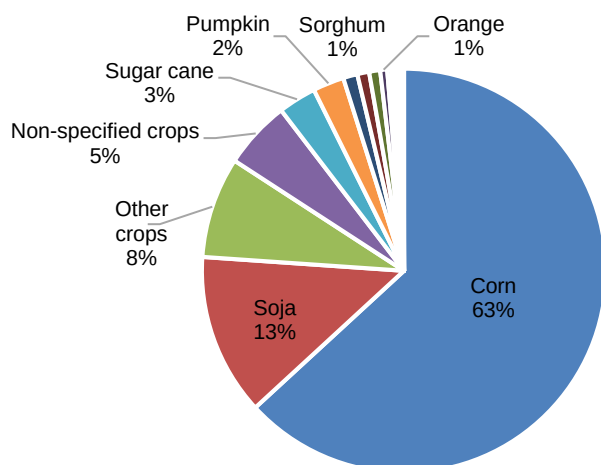


Figure 18: Areas dedicated to open-pit agricultural production according to estimated planted area and main crop in the state of Campeche ⁷⁴.

In the project area and its surroundings, citrus fruits have become an important agricultural product. This is because the climatic conditions in the area facilitate their production and the economic importance of citrus has increased in recent years. Mexico is a leader in citrus production, ranking as the fifth highest producer in the world, (it contributes 4.6% of total global production) behind China (21%), Brazil (18%), the United States (8%) and India (6%). The production of citrus fruits takes place in little over half a million hectares of land in regions with tropical and sub-tropical climates, where production reaches 4.9 million tons per harvest. This consists of mainly orange (83% of the total) and grapefruit (8%).

The cultivation of sweet citrus fruits represents an important source of income in the rural areas in which it is carried out. It is estimated that 69,000 families depend on its production, with an income exceeding 7,100,000,000. Of the three states in the reference area of the project, Tabasco is the largest producer, with approximately 19,000 ha of lemon plantations and 3,520 ha of orange groves (representing less than 1% of the state's area). Campeche ranks second in terms of citrus fruit production. It has 10,627 ha for orange production and 6,370 ha for lemon production. Chiapas, where citrus fruit production is less significant, only has 900 ha of land for their production⁷⁵.

In recent years, the federal government has made several investments and carried out various activities through SAGARPA to promote the production of oranges and other citrus fruits at a national level. Some important examples are:

- The National Productive Reconversion Program of the Citrus Chain;
- The use of technology in irrigation to optimize the use of water for crops (especially in the production of oranges);
- The certification of nurseries to ensure the absence of diseases and pathogens in crops;

⁷⁴ Source: Update on the Agricultural Census Framework (2016) - National Institute of Statistics and Geography (INEGI).

⁷⁵ Update of the Agricultural Census Framework 2016. National Institute of Statistics and Geography (INEGI). Retrieved from <http://www.beta.inegi.org.mx/proyectos/agro/amca/>.

- The implementation of good agricultural practices to ensure high quality harvests and to meet the demands of the national and international markets;
- The strengthening of the production-consumption chains;
- Infrastructure support for post-production.

All the initiatives described above are carried out so that producers have better channels to market and market diversification⁷⁶.

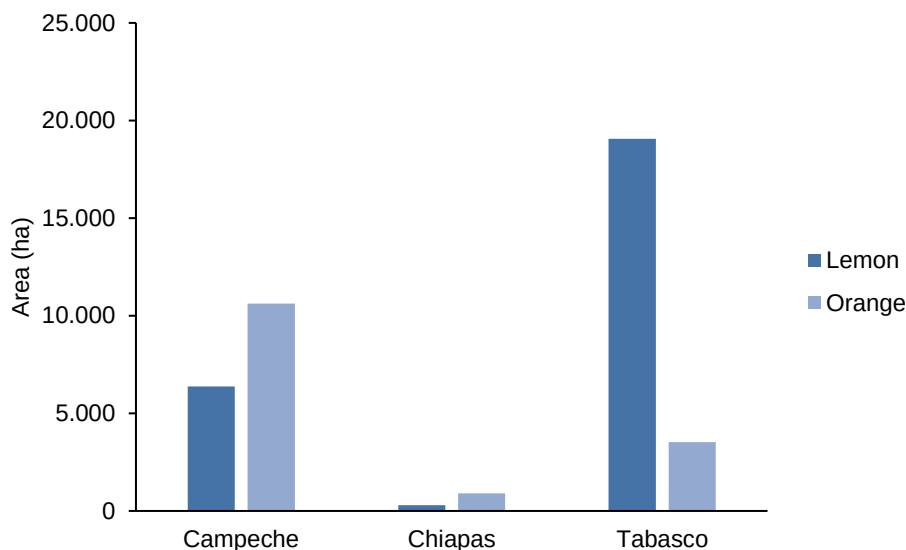


Figure 19: Areas dedicated to the production of citrus fruits (orange and lemon) according to the sown area estimated in the project reference area ⁷⁷.

Alternative 2: Cattle

At present, livestock production is an important economic activity in Mexico. It occurs across rural parts of the country, even in adverse environmental conditions that are prohibitive to other productive activities⁷⁸. In 2016, the livestock production area was 480,674 km², (24.5% of the total area of the country) and was distributed between 830,127 communal, private and public land plots⁷⁹. Mexico is the seventh highest producer of bovine animal protein worldwide; the country shows high development potential and competitive advantages in this sector.

In Tabasco, bovine production dominates, both in carcass and standing, and it is practiced in approximately 12,673 km² of land, which represents 51.2% of the state's area. Overall, slightly more than 82% of the state's area is dedicated to the primary sector. The state has a registry of 1,512,000 head of cattle, of which about 85% is raised under extensive grazing systems, 10% under semi-intensive grazing and only 5% is

⁷⁶ Boletín - Mexico, among the leaders in citrus production worldwide. Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA). Retrieved from <http://www.sagarpa.gob.mx/Delegaciones/sanluispotosi/boletines/Paginas/BOL1301112.aspx>.

⁷⁷ Source: Update on the Agricultural Census Framework (2016) - National Institute of Statistics and Geography (INEGI).

⁷⁸ Article - Livestock in Mexico. Shared Risk Trust (FIRCO). Retrieved from <https://www.gob.mx/firco/articulos/lagranaderia-en-mexico?idiom=es>.

⁷⁹ Update of the Agricultural Census Framework 2016. National Institute of Statistics and Geography (INEGI). Retrieved from <http://www.beta.inegi.org.mx/proyectos/agro/amca/>.

raised under feedlot. In the state there are approximately 52,969 cattle producers, of which 54.7% are low scale or subsistence, with between 1 and 20 heads of cattle. This amounts to 15% of the state's total production. These producers supplement their income with other means such as agriculture and the raising of some animals (such as sheep, pigs and poultry⁸⁰). Cattle farming represents 92% of the value of the production of the entire economic primary sector and, because of the size of the tropical plain in Tabasco and its biophysical conditions, it has been possible to maintain extensive livestock, providing food through direct grazing⁸¹.

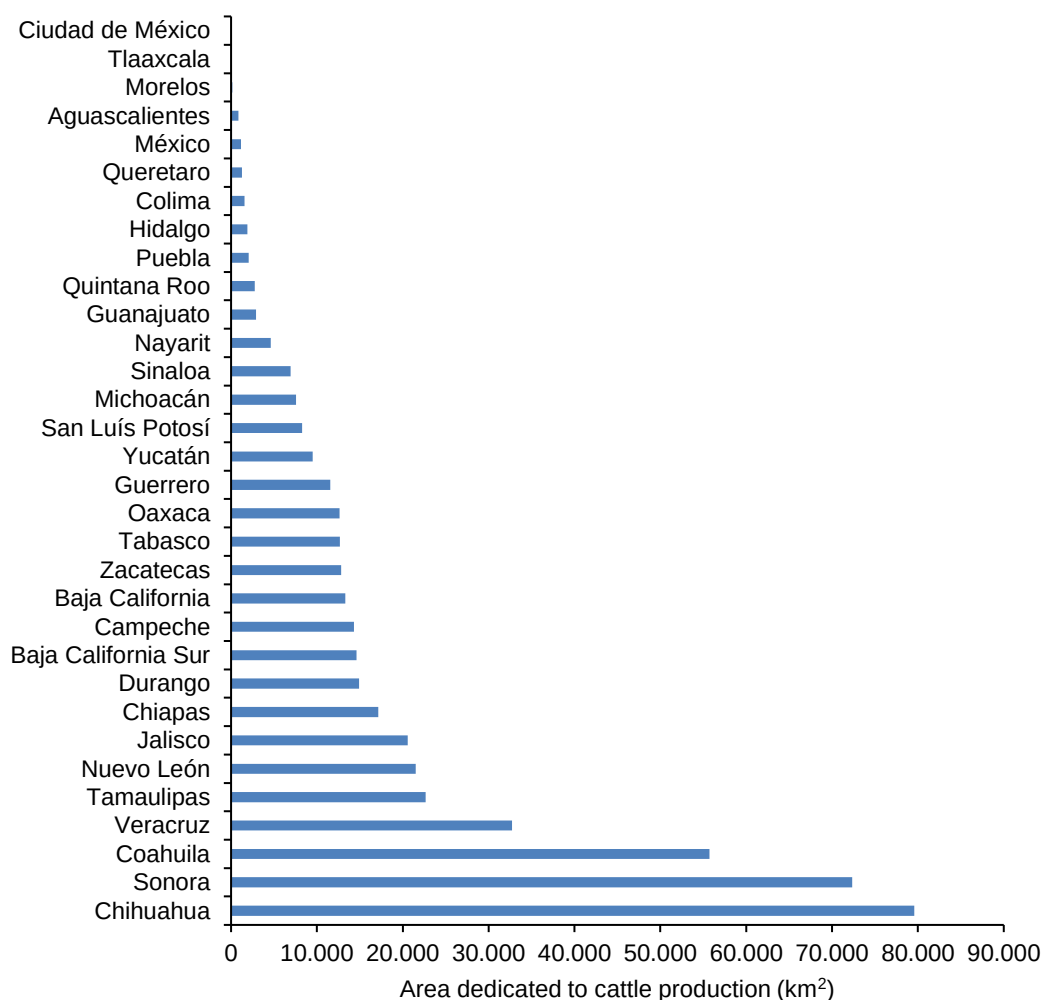


Figure 20: Areas dedicated to the cattle production of bovines by state entity ⁸².

80 Government of the State of Tabasco. Sectoral Program for Agricultural, Fishing and Food Development 2013-2018. Retrieved from https://www.gob.mx/fnd/documentos/programa-sectorial-de-desarrollo-agropecuario-pesquero-y-alimentario-2013-2018_dof.

81 Tabasco: Characteristics and Socioeconomic Impact of the Floods Caused at the End of October and at the Beginning of November 2007 by the Cold Front. Bulletin Number 4. Retrieved from https://www.cepal.org/publicaciones/xml/3/33373/l864_parte_6_de_8.pdf.

82 Source: Update on the Agricultural Census Framework (2016) - National Institute of Statistics and Geography (INEGI).

In the state of Chiapas, 73,681 km² of land is dedicated to cattle production⁸³ (23.3% of the total area), across more than 105,000 farms. For the most part, livestock systems are carried out extensively with a density of one animal head per hectare. According to the Secretary of Field's records, livestock is the second most important economic activity in the state (including indigenous community). Raising bovine is practised in all parts of the state, and is carried out by about 67,000 people. At present, Chiapas's cattle inventory counts 2.4 million heads, placing Chiapas as the third highest livestock producer in the country. Due to its geographic location, this state has strategic relevance for the development of various livestock species. The richness of its natural resources allows for the exploitation of cattle, sheep, pigs, birds and bees, and the creation of alternative livestock systems, such as the raising of exotic species like iguanas, and deer, among others⁸⁴. Additionally, productive reconversion schemes have been developed that have allowed the recovery of degraded areas from silvopastoral systems⁸⁵.

In Campeche, livestock production is practised in about 57,727 km² (24.8% of the state's area), distributed over more than 14,000 community plots and private properties. Among the main rural activities, livestock ranks second contributing 34.1% the total value of the production of the primary sector. Cattle generate 58.2% of the value of livestock production, followed by chicken (28.4%), pigs (9.8%), sheep (3.6%) and goats (0.1%)⁸⁶.

Table 7: Area dedicated to cattle production by state and type of producer in the reference area of the project ⁸⁷.

Federative entity	Area with livestock activity (km ²)	Type of producer			
		Large producers		Small producers	
		Land units	Area (km ²)	Land units	Area (km ²)
National	480,674.26	39,629	116,230.06	790,498	364,444.19
Campeche	14,300.3	2,696	3,641.86	21,078	10,658.43
Chiapas	79,590.61	1,735	26,211.20	18,047	53,379.4
Tabasco	12,673.71	1,978	8,655.29	66,759	11,808.18

83 Update of the Agricultural Census Framework 2016. National Institute of Statistics and Geography (INEGI). Retrieved from <http://www.beta.inegi.org.mx/proyectos/agro/amca/>.

84 State Development Plan, Chiapas 2013-2018. Government of the State of Chiapas. Retrieved from <http://chiapas.gob.mx/plan-estatal>.

85 Government of the State of Chiapas. Sectorial Program for Sustainable Rural Development. Retrieved from <http://www.planeacion.chiapas.gob.mx/programasectoriales/Programa%20Sectorial%20de%20Desarrollo%20Rural%20Sustentable%202013-2018.pdf>.

86 State Development Plan 2015-2021. Government of the State of Campeche - Committee for Planning for State Development (COPLADE). Retrieved from <http://www.comunicacampeche.com.mx/Php/locales.php?id=147038>.

87 Source: Update on the Agricultural Census Framework (2016) - National Institute of Statistics and Geography (INEGI).

At the state level, the government promotes the establishment of cattle sector programs with the following aims:

- To increase of the number of livestock;
- To generate economic stimuli that is easily accessible to low-income producers;
- To improve facilities and production centre equipment;
- To support women's groups.

This is done to generate optimal conditions for increasing the profitability, sustainability and production of livestock. Furthermore, sectoral development programs promote the infrastructure required by producers, supporting the generation of basic productive infrastructure projects and collection and marketing centres. Technical assistance and training programs have also been created to strengthen channels to market and bring new technologies to smaller producers.

The Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA) have generated different incentives through the Shared Risk Trust (FIRCO)⁸⁸ and the Livestock Development Program⁸⁹. They aim to increase the productivity of the Livestock Economic Units and improve, through investment, the conditions for production of livestock at the national level. The components of this program include:

- The delivery of economic support to increase efficiency in livestock raising (Component *PROGAN Productivo*);
- The acquisition of assets that allow a substantive technological change in livestock (Research, Innovation and Technological Development Livestock component);
- The generation of economic incentives for livestock production, breeding, reproduction and genetic material, livestock management, among others (Integral Strategies of the Production Chain component);
- The creation of funds for the acquisition of productive assets, infrastructure, machinery and equipment, well drilling, all to contribute to increased system productivity (Productive Capitalization of Livestock component).

Forest plantations not certified under the VCS

The promotion of commercial forest plantations has been identified as a priority in Mexico. This strategy aims to increase forest production and help reduce the deficit in the supply of raw forest materials, while generating economic opportunities in different rural areas in the country. However, the establishment of forest plantations as an economic activity requires significant investment and has long payback periods. In addition to the technological requirements for the preparation of land, the management needs of plantations are high. As a result, commercial forests are supported by government incentives that aim to reduce the costs and risk of investments⁹⁰.

In Mexico, there are approximately 7 million hectares of land suitable for developing commercial forest plantations, of which 80% are in tropical and sub-tropical regions of the country. They have favourable soil

⁸⁸ Instrument of governmental policy, with which it contributes to the integral development of the rural sector, through the channeling of complementary economic resources, which minimize the risk involved in undertaking investments to strengthen chains and productive diversification.

⁸⁹ Cattle Development Program. Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA). Retrieved from http://www.sagarpa.gob.mx/ProgramasSAGARPA/2014/Fomento_Ganadero/Paginas/default.aspx.

⁹⁰ The Forest Plantations in Mexico. Electronic Magazine of Forestry Scientific Disclosure. Ministry of Environment and Natural Resources (SEMARNAT), National Forestry Commission (CONAFOR) and Fund CONACYT. Retrieved from http://www.conafor.gob.mx/innovacion_forestal/?p=2350.

types and climates, which achieve rapid growth. They also have good labour availability, as well as internal market demands for raw forest materials⁹¹. In 2015, the states of Campeche, Chiapas, Chihuahua, Durango, Mexico, Michoacán, Oaxaca, Puebla, Tabasco and Veracruz were prioritised to establish forest plantations, given that they have soils with high potential for forestry, and are where the forestry subsector has remained subordinate to livestock and agriculture for the past 40 years. Despite the efforts of entities such as the National Forestry Commission (CONAFOR), the Secretariat of Energy (SENER), Natural Resources and Environmental Protection (SEMARNAT) and the Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA), it has not been possible to maintain production all year-round. This has been attributed to the young average age of the plantations, the fact that the industry is in its primary stages, and the geographic isolation of rural properties. In addition, primary forestry activities, such as forestry, and secondary activities, such as extraction and industrialization of wood, are considered part-time or temporary work in most communities, where labour is scarce and poorly qualified⁹².

According to data from the Agricultural Census Framework, forest use is still relegated with respect to agriculture and livestock. At the national level, the areas where forest is the main coverage reached 17,909 km² in 2016, while land used for agricultural and livestock reached 472,730 km² and 480,674 km², respectively. Within the reference area of the project, Chiapas is the main producer with nearly 1,247 km² of land dedicated to this activity, across 600 productive units. That said, this area is only equivalent to 1.5% of the area dedicated to extensive cattle raising and the planted areas are generally monospecific stands of Pinus, for which exists a technological package for its establishment and management.

Table 8: Area dedicated to forestry production by state and type of producer, in the reference area of the project⁹³.

State	Area with forestry activity (km ²)	Producer type			
		Large producers		Small producers	
		Productive units	Area (km ²)	Productive units	Area (km ²)
National	17,909.26	699	2,933.17	62,174	14,976.08
Campeche	832.94	121	405.19	653	427.74
Chiapas	1,247.06	12	428.92	588	818.13
Tabasco	668.82	55	54.75	1,768	614.06

In the state of Campeche, cedar (*Cedrela sp*) production has contributed the most to the state GDP. There are approximately 13,000 ha planted with cedar, but other species of conifer and broadleaved plants are also found in this state, which had 833 km² of forest in 2016. Agriculture remains the main productive activity

⁹¹ Commercial Forest Plantations. National Forestry Commission (CONAFOR). Retrieved from <http://www.conafor.gob.mx/web/temas-forestales/plantaciones-forestales/>.

⁹² Achievements and perspectives of forestry development in Mexico 2007-2012. Ministry of Environment and Natural Resources (SEMARNAT) and National Forestry Commission (CONAFOR). Retrieved from <http://www.conafor.gob.mx:8080/biblioteca/ver.aspx?articulo=489>.

⁹³ Source: Update on the Agricultural Census Framework (2016) - National Institute of Statistics and Geography (INEGI).

in terms of land use. Forest use only occupies 3.5% of the agricultural area. In Tabasco, forest of mainly hevea (*Hevea brasiliensis*) and cedar (*Cedrela sp*) cover 669 km². As for the other states, forestry activity remains in its initial phases with respect to livestock and agriculture, with 5.3 and 16.6% of the area covered by these land uses, respectively⁹⁴.

One of the objectives of the National Forestry Program 2013-2018 (PRONAFOR)⁹⁵ is to increase sustainable production of wood and forest productivity by establishing commercial forest plantations. Its goals are to increase the area of forest plantations to 384,661 ha by 2018 by giving direct subsidies to plantations, promoting access to credit, increasing the technical capabilities of those involved in the production process and promoting public-private partnerships for the development of forest plantations. To achieve these goals, the program seeks the participation of different levels of government and community organizations to reduce the social, technological and economic barriers faced when establishing forest plantations.

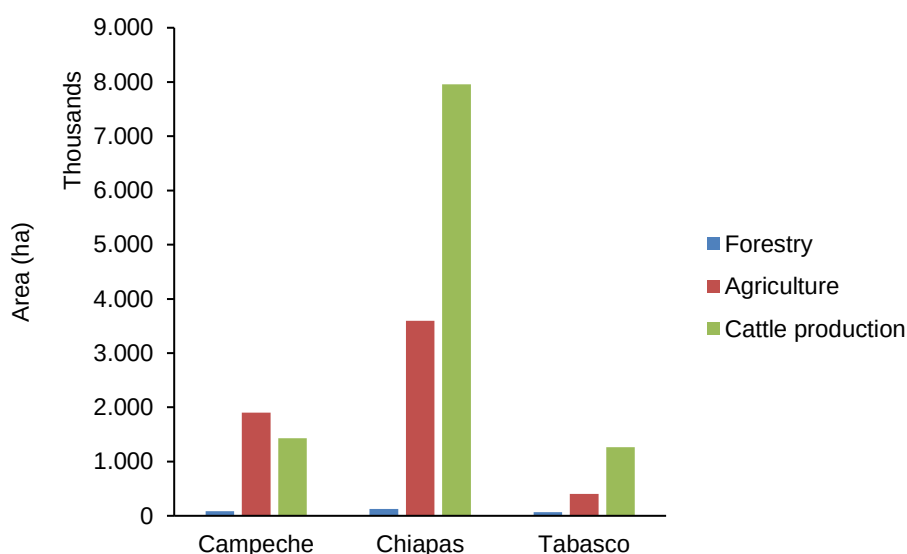


Figure 21: Comparison land use for forest, agriculture and livestock by state in the project area⁹⁶.

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

All land use scenarios resulting from sub-step 1a apply and are governed by mandatory laws and regulations across all Mexico's states. None of the scenarios were eliminated using this criterion.

According to Article 27 of the Political Constitution of the United Mexican States⁹⁷, given that the nation has the right to regulate the use of natural elements susceptible to appropriation, the government will also

94 Update of the Agricultural Census Frame 2016. National Institute of Statistics and Geography (INEGI). Retrieved from <http://www.beta.inegi.org.mx/proyectos/agro/amca/>.

95 National Forestry Program 2013-2018 (PRONAFOR). National Forestry Commission (CONAFOR). Retrieved from <http://www.conafor.gob.mx/web/apoyos/pronafor/>.

96 Source: Update on the Agricultural Census Framework (2016) - National Institute of Statistics and Geography (INEGI).

97 Political Constitution of the United Mexican States. National Secretariat of the Interior. Retrieved from http://www.dof.gob.mx/constitucion/marzo_2014_constitucion.pdf.

dictate the necessary measures to order human settlements and establish adequate provisions, uses, reserves and destinations of lands, waters and forests for the promotion of agriculture, livestock, forestry and other economic activities in rural areas. On a local level, this article states that each state will promote integral rural development, which includes facilitating agricultural and forestry activities that make the best use of land. They will also provide infrastructure, inputs, credit and training.

Mexico Prospero, which is section IV of the National Development Plan 2013-2018 (PND)⁹⁸, states in objectives 4.4 and 4.10 that the nation will promote and guide green, inclusive growth that preserves natural heritage, while generating wealth, competitiveness and employment. It allows for the construction of a productive agricultural sector that guarantees food security for the country. This implies that Mexico recognizes the use of the agricultural, livestock and forestry land for economic activities as legal.

2.5.2 Step 2. Barrier analysis

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

According to the Agenda for Development published by the National Autonomous University of Mexico (2007), forest plantations in Mexico have been the sector with the least budget and economic benefits when compared to environment and agriculture sectors⁹⁹. Although there is some financing available for the sector, there is not enough entrepreneurial capacity to take advantage of the opportunity. Furthermore, among financial agents, there is little knowledge of forestry, a pervasive perception of risk, and no economic guarantees for its implementation. In terms of the constitutional framework, there has been a disarticulation of government entities in the definition and application of forest policies, strategies, programs and projects¹⁰⁰.

Within the analysis of the Forest Program for the Development of Commercial Plantations (PRODEPLAN)¹⁰¹ and the Specific Institutional Intervention Programs 2014-2018¹⁰², several limitations for the forestry sector have been identified. They are as follows:

- **Time:** Even fast-growing timber species can only be exploited after 10 years. During this time, the forests do not generate much income and/or economic opportunities only arise in the final harvest and, to a lesser extent, for some maintenance work., The long wait for a return on investment can be demotivating for investors.

98 National Development Plan 2013-2018 (PND). Government of the Republic. Retrieved from http://www.snieg.mx/contenidos/espanol/normatividad/MarcoJuridico/PND_2013-2018.pdf.

99 Civil Council for Sustainable Silviculture, A.C (CCMSS) 2004. The management of the federal budget 2004 for the forestry sector. Mexico.

100 Agricultural, Forestry and Fishing Development. (2007). Chamber of Deputies, LX Legislature and National Autonomous University of Mexico. Agenda for Development, volume 9. Retrieved from <http://www.maporrua.com/p-3111-desarrollo-agropecuario-forestal-y-pesquero.aspx>.

101 Program of Development of Commercial Forest Plantations (PRODEPLAN). National Forestry Commission (CONAFOR). Retrieved from http://www.conafor.gob.mx/biblioteca/documentos/PROGRAMA_DE_DESARROLLO_DE_PFC_A_15_ANOS_DE_S_U_CREACION.PDF

102 Program of Commercial Forest Plantations 2014-2018. Ministry of Environment and Natural Resources (SEMARNAT) and National Forestry Commission (CONAFOR). Specific Programs of Institutional Intervention. Retrieved from https://www.gob.mx/cms/uploads/attachment/file/251747/Programa_especifico_de_intervencion_institucional_Plantaciones_Forestales_Comerciales_2014-2018.pdf.

- **Financing and investment:** There is a lack of adequate financing as financial institutions perceive forestry to be a high-risk business. This perception can be attributed to the large productive periods and the little entrepreneurial culture of the producers to seek financing and lack of guarantees by the producers.
- **Access and land tenure:** There is significant irregularity and insecurity in the possession of the properties and in the low productive organization.
- **Technology:** There has been little research into the adaptation and resistance of plant species, quality of seeds, and preparation of soil and crops. In addition, a lack of infrastructure and access to technologies has been identified. In terms of technical assistance, there is a shortage of trained technical professionals in the sector. This results in little local knowledge and experience in the prevention of fires, pests and diseases in the plantations, and has created a dependence on external experts. The link between planters and teaching and research institutions is very limited.
- **Markets:** Commercialization of the products is limited due to the high geographical dispersion and variability in the raw material (type of species, sizes, type of use). The current scenario corresponds to heterogeneous and small plantations that do not allow harvesting in large volumes with uniform characteristics and properties.
- **Transportation and road infrastructure:** The network of forest roads is poor and transport costs are high. The national average indicates that transportation costs can represent 40-60% of the total extraction cost depending on the state of the forest roads¹⁰³.

Bearing in mind all these barriers, and the achievements and perspectives of forest development in Mexico, it is evident that forest management has been limited by the following factors:

- The limited infrastructure of forest roads;
- Low level of technological establishment activities, management and extraction;
- Difficulties in financing and institutional systems;
- A high number of intermediaries and procedures in the search for financing and associativity.

Figure 22 presents the problem tree built by CONAFOR. It gives an overview of the difficulties and barriers that have been identified for the commercial forest plantation sector.

103 FAO. Study of Trends and Perspectives of the forestry sector in Latin America to the year 2020. National Report Mexico. Juan Manuel Torres Rojo. Retrieved from http://www.fao.org/docrep/006/j2215s/j2215s06.htm#P655_52584.

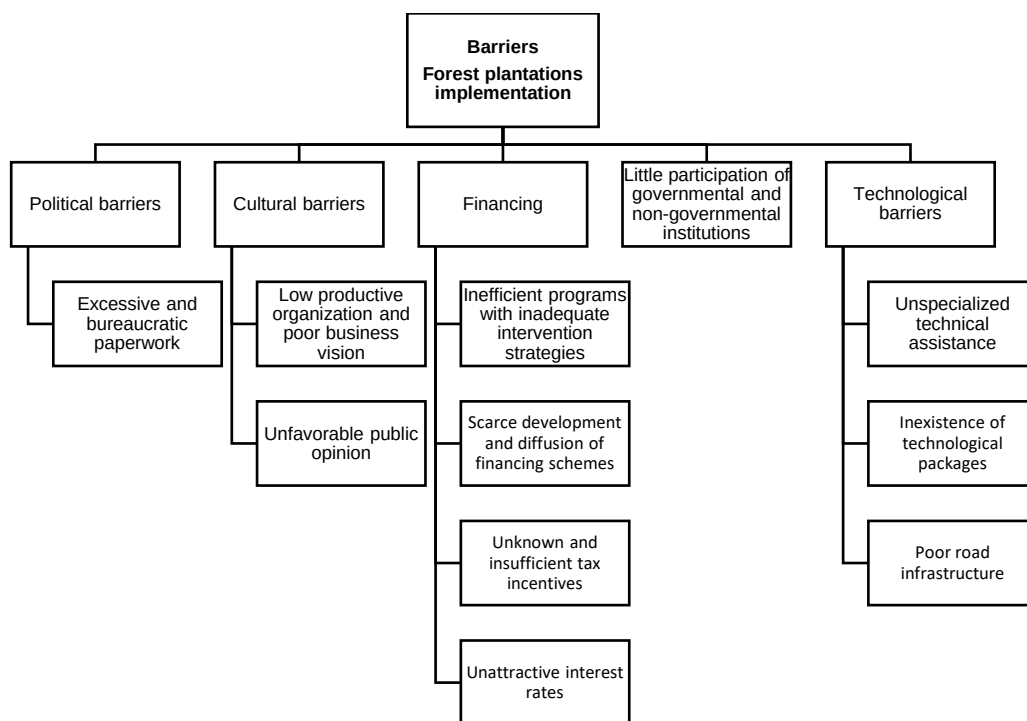


Figure 22: Problem tree for the implementation of commercial forest plantations in Mexico.

On the other hand, the main barriers identified in the agriculture sector are related to land tenure, financing, technology and institutional framework¹⁰⁴:

- **Access and land tenure:** a problem exacerbated by the system of inheritance rights that has historically characterized the processes of land legitimization in Mexico. This situation has had important repercussions on the low profitability of rural households, the migration of the economically active agricultural population (intranational and foreign), the increase in rent prices, the lack of association farming and the weakening of economies of scale.
- **Technology:** the Mexican countryside is characterized by low productivity, low added value and the existence of a technological gap with its partners and competitors, which influences regional specialization, the deepening of productive heterogeneity and faults in technology transfer systems. Mexican agriculture is characterized by low technological development for producers in transition (the majority of producers in Mexico); the existence of agricultural areas with poor quality soils, systems with overexploitation of inputs and machinery, economic inefficiency and depletion of resources, poor evaluation of production systems to promote improvements in the supply chains, a low number of Mexican academic researchers in proportion to the population, the weakness of research institutions and low investment in technological development.
- **Financing and investment:** among the most significant barriers, low access to financing stands out because the Mexican financial system does not fulfill its role of intermediation between savings and loans. This is because its priority is to generate profitability in the shortest amount of time

¹⁰⁴ Salcido, G. T. & Morales, M. (2011). The great challenges and perspectives for agriculture and the rural sector in Mexico in the 21st century. Retrieved from http://www.pa.gob.mx/publica/rev_49/Análisis/los_grandes_retos_-_Gerardo_Torres.pdf.

possible, and not in the selection of projects with economic development potential, which has discouraged the permanence of agricultural systems in rural areas. On the other hand, the resources allocated to agriculture are directed, primarily, to social spending, since only 12.5% can be classified as support for production due to the great dispersion and lack of articulation of the programs oriented towards the agricultural sector. According to the Interagency Group for Rural Development in Mexico¹⁰⁵, of the 1,800 million pesos used by banks for financing in the first quarter of 2010, only 2% were allocated to the agricultural sector and, of this proportion, 86% went to short-term loans.

- **Institutional barriers:** low territorial presence of the relevant institutions has been identified, which also generates financing barriers. It is estimated that 30% of the country's municipalities do not have financial services, including ATMs. The effects of this scarce access to credit are differentiated, since they affect more the producers in transition to the market economy, who depend on income from farming, fishing or forestry activities. On the other hand, the level of organization of farmers, especially poor farmers in marginalized areas, remains low and weaknesses in agricultural training and advice have been identified. Many systems have not provided sufficient resources to train their personnel and update their knowledge and interaction with specialists in the sector remains very low.

Sub-step 2b. Elimination of land use scenarios that are prevented by the identified barriers.

Extensive livestock farming is the only land use alternative that does not face any of the identified barriers. For this reason, it is the base scenario. Table 9 shows the list of land use scenarios and the respective limitations or barriers identified.

Table 9: The use of land and the barriers identified

Alternative land use	Type of barrier
Livestock	No barrier. In general, it is one of the most common land uses in Mexico, especially in rural areas. It is carried out without exception across every region of the country, even under adverse climatic conditions and on unsuitable land ¹⁰⁶ .
Forest plantations not certified under VCS	Time, financing, access and land tenure, technology, markets and transportation infrastructure.
Agriculture	Access and land tenure, technology, financing and institutional barriers.

¹⁰⁵ Grupo Interagencial de Desarrollo Rural en México. (2010). Análisis de los Problemas de Desarrollo del Medio Rural de México. Disponible en: <http://smye.info/gia-mexico/wp-content/uploads/2010/08/Informe-Reunion-de-Expertos-final.pdf>

¹⁰⁶ Article - Livestock in Mexico. Fideicomiso de Riesgo Compartido (FIRCO). Retrieved from <https://www.gob.mx/firco/articulos/la-ganaderia-en-mexico?idiom=es>.

2.5.3 Step 3. Investment analysis

The investment analysis was not applied. See Step 2.

2.5.4 Step 4. Common practice analysis

The establishment and management of forest plantations is not a common practice in the expansion area of the grouped project. This can be seen by the total land area that has reforestation as its main activity. This is even more evident when reforestation area figures are compared with the areas occupied by agriculture and livestock (Figure 21). Although the development of commercial forest plantations has been identified as a priority economic activity in the country, different barriers hinder its implementation in the project area. Of these, the most significant barriers are financing, technological management and the participation of state entities. Additionally, up until now, established forestry plantations have had a strong dependence on i) technological packages of the species and ii) community knowledge of the timber species, which is why the planting of conifers, especially the pinus genus, has been privileged, in addition to eucalyptus, cedar and rubber hevea. According to information from the National Forestry Commission (CONAFOR), only 9% of the country's forest plantations are teak (*Tectona grandis*).

Since the cutting cycle (rotation) of the species administered by AGSA is 18 years, there are no projects that resemble the scale or duration of the rotation cycle of the species. The plantations that are already under use are mainly eucalyptus and gmelina, often owned by small producers and generally with a cutting cycle of 5 to 10 years. The other company that has planted teak (Proteak) has a similar rotation cycle, however, it has remained at 8,300 ha, without growth since 2016¹⁰⁷. In comparison, AGSA has had a growth of around 1,200 ha per year. In addition, Proteak has focused on harvesting and planting fast-growing species such as eucalyptus, diversifying and combining its operations with industrial activity for the manufacture of MDF boards. Table 10 presents a brief summary of the companies that are located in the region where the project is developed¹⁰⁸ and also presents the main differences with the project activities.

Table 10: Difference between AGSA plantation and other plantations located in the expansion area of the grouped project

Company	Location	Plantation Description	Difference between AGSA and the company
Proteak Uno S.A.P.I.B	Tabasco	8,300 ha of teak including the operation in Costa Rica and Colombia	- Currently diversified with the acquisition of FOMEX that supplies the eucalyptus wood for its MDF plant. - AGSA only has plantations in Mexico.
Forestales Operativas de México S.A. de C.V.	Tabasco	Over 9,000 ha of eucalyptus	Currently integrated to Proteak Uno S.A.P.I.B.
Promotora de plantaciones del sureste S.A. de C.V.	Tabasco	Producer of eucalyptus and gmelina	Business plan completely different with regards to species, use and rotation cycle.

¹⁰⁷ Proteak Annual Report 2017 page 12 [Supporting documents\Additionality\InformeAnual2017F Proteak]

¹⁰⁸ CONAFOR, Comisión Nacional Forestal (2013) Programa de desarrollo de plantaciones forestales comerciales. A 15 años de su creación. Comisión Nacional Forestal. Zapopan, Jalisco, México. 190 p.

Company	Location	Plantation Description	Difference between AGSA and the company
Forestales Mexicanos de C.V.	Tabasco	Rubber and palm oil producer	Dedicated to palm oil and rubber ¹⁰⁹ .
Ejido San Jerónimo Tulija	Chiapas	Use of natural forest	Use of natural forest is a business model totally different from the teak plantation.
Plantaciones de Hule de Palenque S.A. de C.V.	Chiapas	Rubber production	- The project scale is in the order of 3,000 ha, focusing only on obtaining latex.¹¹⁰ - Species and rotation cycle are different from teak plantations.
Unión de Silvicultores de la región de Escárcega S.P.R. de R.L	Campeche	Small-scale planters supporting the social sector	Managing economic support from government institutions to support the social sector in small areas of the State of Campeche.
Agroindustria Agua Fría S.P.R. de R.L. de C.V.	Campeche	Gmelina Producer	Species and rotation cycle are different from teak plantations.
Rancho Chaparral S.P.R. de R.L.	Campeche	Gmelina Producer	- Integrated to Industrial Agroindustria Agua Fría S.P.R. de R.L. de C.V. - Species and rotation cycle are different from teak plantations.
PROFORCA S.A de C.V.	Campeche	Individual producer	Plantation with little management, without surface growth over time.

In addition to the differences presented in Table 10, AGSA has been a pioneer in the following aspects:

- i. AGSA was the first company to secure financing through the Mexican Stock Exchange to finalize its business plan to establish around 20,000 ha of teak.
- ii. Use of technology, with a focus on experimentation for the development of its operations. In 2006 the production of Teak clones began. Since 2014, these clones have been planted commercially, after selecting the best specimens.
- iii. Despite the unsuccessful effort to promote forest plantations in the area¹¹¹, especially in the States of Tabasco and Campeche, Agropecuaria Santa Genoveva (AGSA) has been the main planter in these locations. According to the Special Forestry Development Program from 2013 to 2018¹¹²

¹⁰⁹ <http://www.induagro.com.mx/HOMEFM/HOMEFM.html>

¹¹⁰ <http://www.agros.com.mx/es-mx/Empresas-del-Grupo/Hule>

¹¹¹ In 2001, when the National Program for the Development of Forest Plantations in Mexico was formally established, the first national program to support the establishment of commercial plantations was introduced. The program created alternatives for sustainable development and productive diversification in Mexico. It did this by converting land that had once been cleared for agricultural purposes to forest.

¹¹² Study presented as supporting document [Supporting documents\Additionality\Copladet_2013_2018].

(annexed reference), with the support of 250 planters, it was planned to establish 7,500 hectares throughout the State of Tabasco, averaging around 30 ha per planter. Recently (between 2013 to 2017), AGSA has planted in the State of Tabasco 4,312 ha of teak, more precisely in the municipalities of Tenosique, Balancán and Huimanguillo (AGSA statistics), areas of land that used to be livestock intensive.

In conclusion, with respect to AGSA, forestry projects that exist in the expansion area of the grouped project are very different in their conception of business, both in scale and focus, with regards to forest and/ or industrial production. The proposed project activities aim to change the land use from livestock and extensive agriculture to activities with a less negative impact on the land. This will allow for the recovery of the natural environment and connectivity between forest cover. The financial income from carbon sequestration will help AGSA to tackle the barriers presented and continue with the activities of plantation expansion and maintenance.

2.6 Methodology Deviations

There are not Methodology Deviations

3 ESTIMATED GHG EMISSION REDUCTIONS AND REMOVALS

3.1 Baseline Emissions

A baseline emissions estimation was carried out using the A/R Methodological AR-TOOL 14 “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities Version 04.2”.

In order to estimate baseline emissions, it is essential to mention the three types of vegetation present in the project area before the start of the project activities:

- Scattered trees and shrubs in a grassland matrix;
- Trees in conservation areas around the grassland matrix; and
- Citrus shrubs in the locality of Huimanguillo.

Trees

According to the AR-TOOL 14, carbon stock in trees in the baseline can be accounted as zero if all of the following conditions are met:

(a) The pre-project trees are neither harvested, nor cleared, nor removed throughout the crediting period of the project activity;

(b) The pre-project trees do not suffer mortality because of competition from trees planted in the project, or damage because of implementation of the project activity, at any time during the crediting period of the project activity;

(c) The pre-project trees are not inventoried along with the project trees in monitoring of carbon stocks but their continued existence, consistent with the baseline scenario, is monitored throughout the crediting period of the project activity.

The trees present in the project area are mainly located in conservation areas (Figure 23). In the case of isolated trees, these are maintained during the project lifetime and not counted in the plot monitoring because only teak trees are quantified (Figure 24). Therefore, the baseline emissions change due to changes in the carbon stocks of trees was accounted as zero.



Figure 23: Areas of conservation and plantation within the site



Figure 24: Trees remaining in the middle of the plantation

Shrubs

Grassland baseline

According to point 12 of the conditions under which carbon stock and change in carbon stock may be estimated as zero, the tool establishes that trees and shrubs in the baseline may be accounted as zero in the case that the land is subjected to periodic cycles (e.g. slash-and-burn, or clearing-regrowing cycles), which is the case of the livestock farming baseline in the project area (see section 3.4: Slash-and-burn is a common practice in the baseline).

According to point 13, for the purpose of ex-ante estimations of carbon stock and change in carbon stock in the project scenario, change in carbon stock of shrubs would be estimated as zero for the grassland baseline.

Citrus crop baseline

According to section 10 of the AR-TOOL 14, the annual change in carbon stock in shrubs must be estimated as follows:

$$\Delta C_{SHRUB,t} = \frac{C_{SHRUB,t_2} - C_{SHRUB,t_1}}{T} \times 1 \text{ year}$$

Where:

$\Delta C_{SHRUB,t}$	Change in carbon stock in shrubs within the project boundary in year t between times t ₁ and t ₂ ; t CO ₂ -e
C_{SHRUB,t_1}	Carbon stock in shrubs within the project boundary at time t ₂ ; t CO ₂ e
C_{SHRUB,t_2}	Carbon stock in shrubs within the project boundary at time t ₁ ; t CO ₂ e
T	Time elapsed between two successive estimations (T= t ₂ – t ₁); yr

In the case of areas localized in Huimanguillo, where there is a citrus crop baseline, the citrus increment is considered to be zero as the citrus plantation is managed to maintain the tree characteristics that allow harvesting activities¹¹³. Then, $\Delta C_{SHRUB,t}$ is assumed to be zero. Additionally, this is consistent with point f of point 12 of the AR-TOOL 14, as the biomass oscillates between a minimum and a maximum value in the baseline due to the management activities.

Dead wood and litter

In the areas where grassland is the baseline scenario, no emissions or removals are attributed to dead wood and litter, considering the activities used to prepare land and the low amount of woody biomass. Regarding the citrus crops, management activities include the cleaning of intercrop corridors and so an accumulation of carbon due to dead wood and litter is not expected.

Soil

¹¹³ Medina-Urrutia, V. M., S. Becerra-Rodríguez, and E. Ordaz-Ordaz. "Crecimiento y rendimiento del limón mexicano en altas densidades de plantación en el trópico." *Revista Chapingo serie horticultura* 10.1 (2004): 43-49. The document is presented in [Supporting documents\Baseline\Medina_Urrutia et al_2003].

In the land use before the project, the amount of organic matter inputs was low, due to the management practices: slash and burn to prepare the land for livestock activities and intercrop corridor maintenance in the citrus plantation. Thus, an increase in the soil carbon stock in the baseline is not expected.

As the baseline emissions were assumed to be zero, no calculations were undertaken. However, if new activity instances are to be included, and baseline emissions are found, the equations of section 3.4 will be applied to calculate the carbon increase in the baseline scenario.

3.2 Project Emissions

The actual net GHG removals by sinks shall be calculated as follows:

$$\Delta C_{\text{ACTUAL},t} = \Delta C_{\text{P},t} - \text{GHG}_{\text{E},t}$$

Where:

$\Delta C_{\text{ACTUAL},t}$	=	Actual net GHG removals by sinks. in year t; t CO ₂ -e
$\Delta C_{\text{P},t}$	=	Change in the carbon stocks in project, occurring in the selected carbon pools. in year t; t CO ₂ -e
$\text{GHG}_{\text{E},t}$	=	Increase in non-CO ₂ GHG emissions within the project boundary as a result of the implementation of the A/R CDM project activity, in year t. as estimated in the tool "Estimation of non-CO ₂ GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity"; t CO ₂ -e

Change in the carbon stocks in project, occurring in the selected carbon pools. in year t; t CO₂-e.

GHG emissions resulting from the removal of herbaceous vegetation, combustion of fossil fuels, fertilizer application, use of wood, decomposition of litter and fine roots of N-fixing trees, construction of access roads within the project boundary, and transportation attributable to the project activity will be considered insignificant and therefore accounted as zero, in accordance with section 5.5 of the AR-ACM0003 methodology. For the activity instances located in Huimanguillo, the carbon stock loss as result of the harvest of citrus plantation (106 tCO₂e)¹¹⁴ to prepare the land was discounted in the carbon estimations.

Carbon emissions due to thinning and harvesting will be accounted in the Net Emission Reductions and Removals estimation.

Increase in non-CO₂ GHG emissions within the project boundary as a result of the implementation of the A/R CDM project activity, in year t.

Increase in non-CO₂ GHG emissions ($\text{GHG}_{\text{E},t}$) within the project boundary as a result of the implementation of the A/R VCS project activity in year t. as estimated in the Annex 31 "Estimation of non-CO₂ GHG

¹¹⁴ Yepes, A., Navarrete D.A., Phillips J.F., Duque, A.J., Cabrera, E., Galindo, G., Vargas, D., García, M.C y Ordoñez, M.F. 2011. Estimación de las emisiones de dióxido de carbono generadas por deforestación durante el periodo 2005-2010. Instituto de Hidrología, Meteorología, y Estudios Ambientales-IDEAM-. Bogotá D.C., Colombia. 32 pp.

emissions resulting from burning of biomass attributable to an A/R CDM project activity version 04.0.0"; t CO₂-e. Considering equation 1 of this tool:

$$GHG_{E,t} = GHG_{SPF,t} + GHG_{FMF,t} + GHG_{FF,t}$$

Where:

$GHG_{E,t}$	=	Emission of non-CO ₂ GHGs resulting from burning of biomass and forest fires within the project boundary in year t; t CO ₂ -e
$GHG_{SPF,t}$	=	Emission of non-CO ₂ GHGs resulting from use of fire in site preparation in year t; t CO ₂ -e
$GHG_{FMF,t}$	=	Emission of non-CO ₂ GHGs resulting from use of fire to clear the land of harvest residue prior to replanting of the land or other forest management. in year t; t CO ₂ -e
$GHG_{FF,t}$	=	Emission of non-CO ₂ GHGs resulting from fire. in year t; t CO ₂ -e
t	=	1.2.3. ... years counted from the start of the project activity

According to the tool "Estimation of non-CO₂ GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity", the emission of non-CO₂ GHGs resulting from burning of biomass and forest fires within the project boundary in year t is an estimate based in three sources: i) burning of biomass and forest fires within the project boundary; ii) use of fire in site preparation; and iii) use of fire to clear the land of harvest residue prior to replanting of the land or other forest management. Source i) is not considered in the ex-ante estimations as the risk of fires is low. However, in each monitoring report, the emissions resulting from burning in the project area will be included. Sources ii) and iii) were considered to be zero, as the project activities do not include the use of fires to prepare land or harvest activities. Considering the previous description, non-CO₂ GHG emissions ($GHG_{E,t}$) are considered to be zero.

3.3 Leakage

According to AR-TOOL15 "Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity" Version 2.0, leakage is all those emissions which occur when the displacement of pre-project agricultural activities leads to an increase in GHG emissions relative to the GHG emissions attributable to the activity as it exists within the project boundary. According to Equation 1 of AR-TOOL15 and the behaviour of the agricultural activities in the project scenario, leakage emissions resulting from displacement of activities are estimated as follows:

$$LK_{AGRIC, t} = \frac{44}{12} * (\Delta C_{BIOMASS,t} + \Delta SOC_{LUC,t}) = 0$$

$$\Delta C_{BIOMASS,t} = [1.1 \times b_{tree} \times (1 + R_{tree}) + b_{SHRUB} \times (1 + R_s)] \times CF \times A_{DISP,t}$$

$$\Delta SOC_{LUC,t} = SOC_{REF} \times (f_{LUP} \times f_{MGP} \times f_{INP} - f_{LUD} \times f_{MGD} \times f_{IND}) \times A_{DISP,t}$$

Where:

$LK_{AGRIC, t}$	=	Leakage emissions resulting from displacement of agricultural activities in year t; t CO ₂ e
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$\Delta C_{BIOMASS,t}$	= Decrease in carbon stock in the carbon pools of the land receiving the activity displaced in year t; t d.m
CF	= Carbon fraction of woody biomass; dimensionless
$A_{DISP,t}$	= Area of land from which agricultural activity is being displaced in year t; ha
b_{tree}	= Mean above-ground tree biomass in land receiving the displaced activity; t d.m. ha ⁻¹
R_{tree}	= Root-shoot ratio for trees in the land receiving the displaced activity; dimensionless.
b_{SHRUB}	= Mean above-ground shrub biomass in land receiving the displaced activity; t d.m. ha ⁻¹
R_s	= Root-shoot ratio for shrubs in the land receiving the displaced activity; dimensionless
$\Delta SOC_{LUC,t}$	= Change in soil organic carbon (SOC) stock due to land-use change in the land receiving the displaced activity in year t; tC ha ⁻¹
SOC_{REF}	= SOC stock corresponding to the reference condition in native lands by climate region and soil type applicable to the land receiving the displaced activity; t C ha ⁻¹
$f_{LUP}, f_{MGP}, f_{INP}$	= Relative SOC stock change factors for land-use, management practices, and inputs respectively, applicable to the receiving land before the displaced activity is received; dimensionless
$f_{LUD}, f_{MGD}, f_{IND}$	= Relative SOC stock change factors for land-use, management practices, and inputs respectively, applicable to the receiving land after the displaced activity has been received; dimensionless
t	= 1, 2, 3, ...years elapsed since the start of the A/R CDM project activity.

3.3.1 Leakage due to displacement of livestock activities

In general, the owners of the acquired livestock lands are adults who sold their lands with the intention of moving away from field-based activities (See section 3.3.1.1) in particular moving to some cities and/or migrating to areas already degraded (See section 3.3.1.2), which therefore presents no displacement of emissions.

3.3.1.1 Migration phenomenon

Mexico is experiencing a decrease in its rural population (Figure 25), which is attributed to an emigration phenomenon from rural to urban areas¹¹⁵. In the case of the expansion area of the grouped project, the states of Chiapas and Tabasco, where the majority of the activity instances included during the validation are located, the population that is emigrating is bigger than the population that is immigrating, so resulting in an overall decrease in the rural population (Table 11).

¹¹⁵ http://cuentame.inegi.org.mx/poblacion/rur_urb.aspx?tema=P

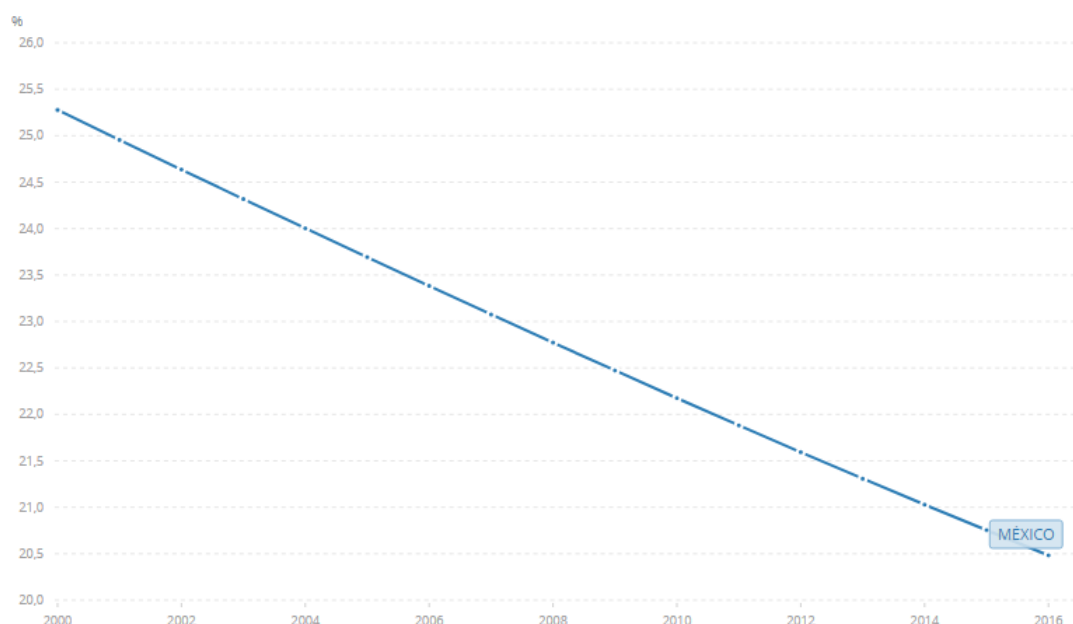


Figure 25: Percentage of the rural population in Mexico with respect to the total population

Table 11: Migration behaviour in the states of Tabasco, Campeche and Chiapas¹¹⁶.

State	2000			2010		
	Immigrant	Emigrant	Net balance	Immigrant	Emigrant	Net balance
Tabasco	178,683	235,392	-56,709	197,670	311,328	-113,658
Campeche	156,158	89,223	66,935	180,252	109,734	70,518
Chiapas	122,451	336,140	-213,689	140,135	491,000	-351,784

3.3.1.2 Livestock activity

The south of Mexico, where the expansion area of the project is found, has been impacted for decades by policies that incentivise agricultural production. The best example of this is the National Tree Clearing Program (in Spanish, PRONADE), where the Government allocated land to peasants and the National Commission of DESMONTES provided loans to farmers to encourage them to remove vegetation from their lands, as well as the National Farming Program to incentivise changing land use from forest to pasture or agriculture. Following these policies, from the 1970s to 1985, the farming sector showed considerable growth and the area of land devoted to livestock cultivation and foraging increased by more than 100%¹¹⁷¹¹⁸.

¹¹⁶ Instituto Nacional de Estadística y Geografía (INEGI). Población total inmigrante, emigrante y saldo neto migratorio por entidad federativa, 2000 y 2010. Available in: http://www.beta.inegi.org.mx/app/tabulados/pxweb/inicio.html?rxid=d728b6e6-f385-4f2f-8617-a313fab3de41&db=Migracion&px=Migracion_1

¹¹⁷ Cerdeño Gilardi Heidi y Pérez Salicrup Diego R. La legislación forestal y su efecto en la restauración en México. Instituto nacional de Ecología y Cambio Climático. 2007. Disponible en <http://www2.inecc.gob.mx/publicaciones2/libros/467/cedenoyperrez.html>

¹¹⁸ Moreno Unda, Arcelia A. Efectos ambientales del Programa Nacional de Desmontes, 1972-1982. 2011. Disponible en <http://ninive.uaslp.mx/jspui/handle/i/3541> y comunidadpmpca.uaslp.mx/documento.aspx?idT=123

In the event that the previous owner of the land purchased by AGSA continues with farming activities, these would be transferred to already-degraded areas, where the number of livestock would not exceed the load capacity of the system for the following reasons:

- Availability of area with farming as current land use:

The incentives mentioned above led to the current situation in the states that make up the expansion area of the project: that is to say, that the predominant land use type in these three areas is agricultural. Of the five municipalities that are located in the project area, four are characterised by having large tracts of land dedicated to farming (Table 12). In addition to this, the migration phenomenon mentioned previously has meant that rural land is available at lower prices than in other regions of the country. Finally, the change of land use from areas of natural vegetation to pastures is not a viable scenario due to the high cost of soil preparation and the current legislation that prohibits such actions in forest areas.

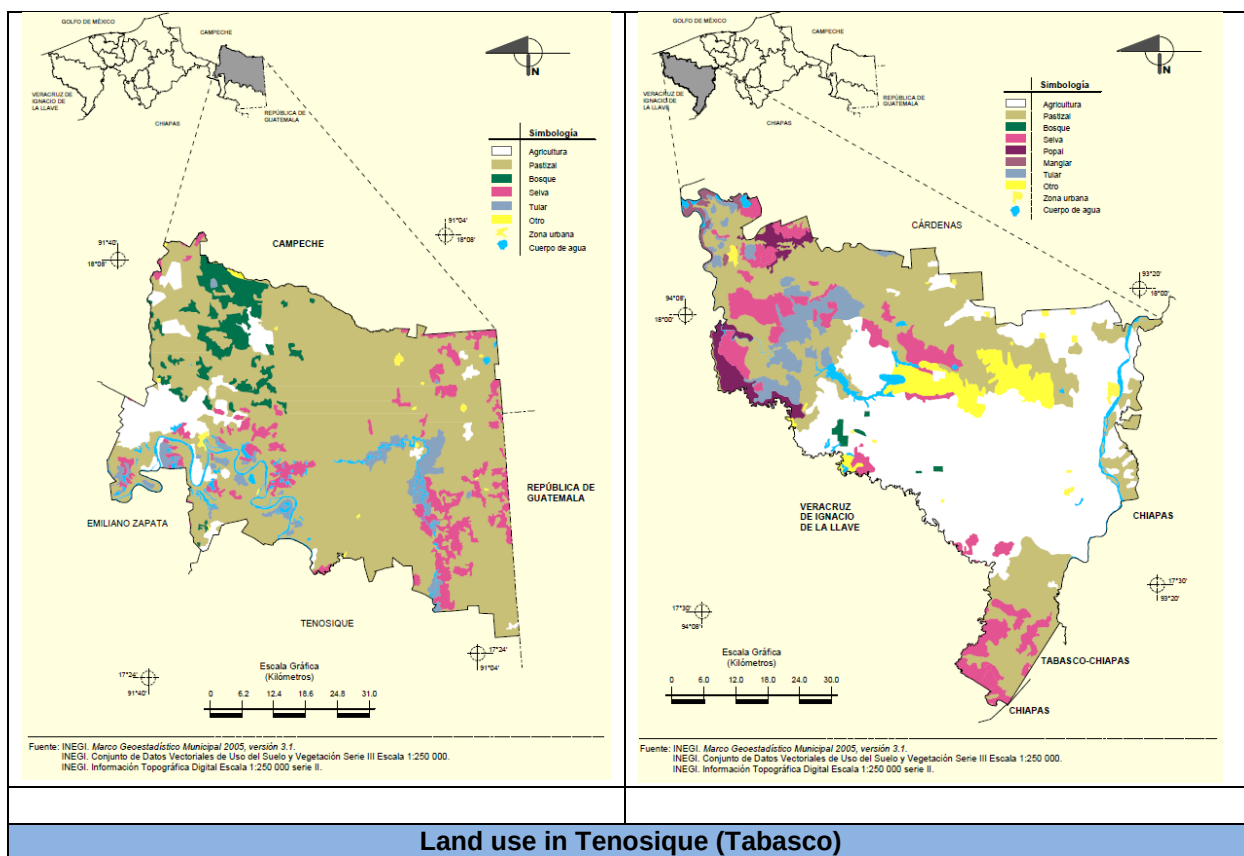
- Type of farming practiced in the region:

In section 2.5.1, where alternative land uses are described, it was reported that the type of farming practiced in the area is extensive grazing with an average density of one head of cattle per hectare. To increase the load capacity, it would be necessary to increase the number of livestock in the pre-project scenario, which is not expected because the sale of the farms to AGSA was made because the previous owners no longer had the capacity to maintain livestock due to the migration of young people to the cities. So, if animals in the pre-project scenario were displaced to existing grazing lands, the total number of animals in the receiving lands would not exceed the carrying capacity of the land.

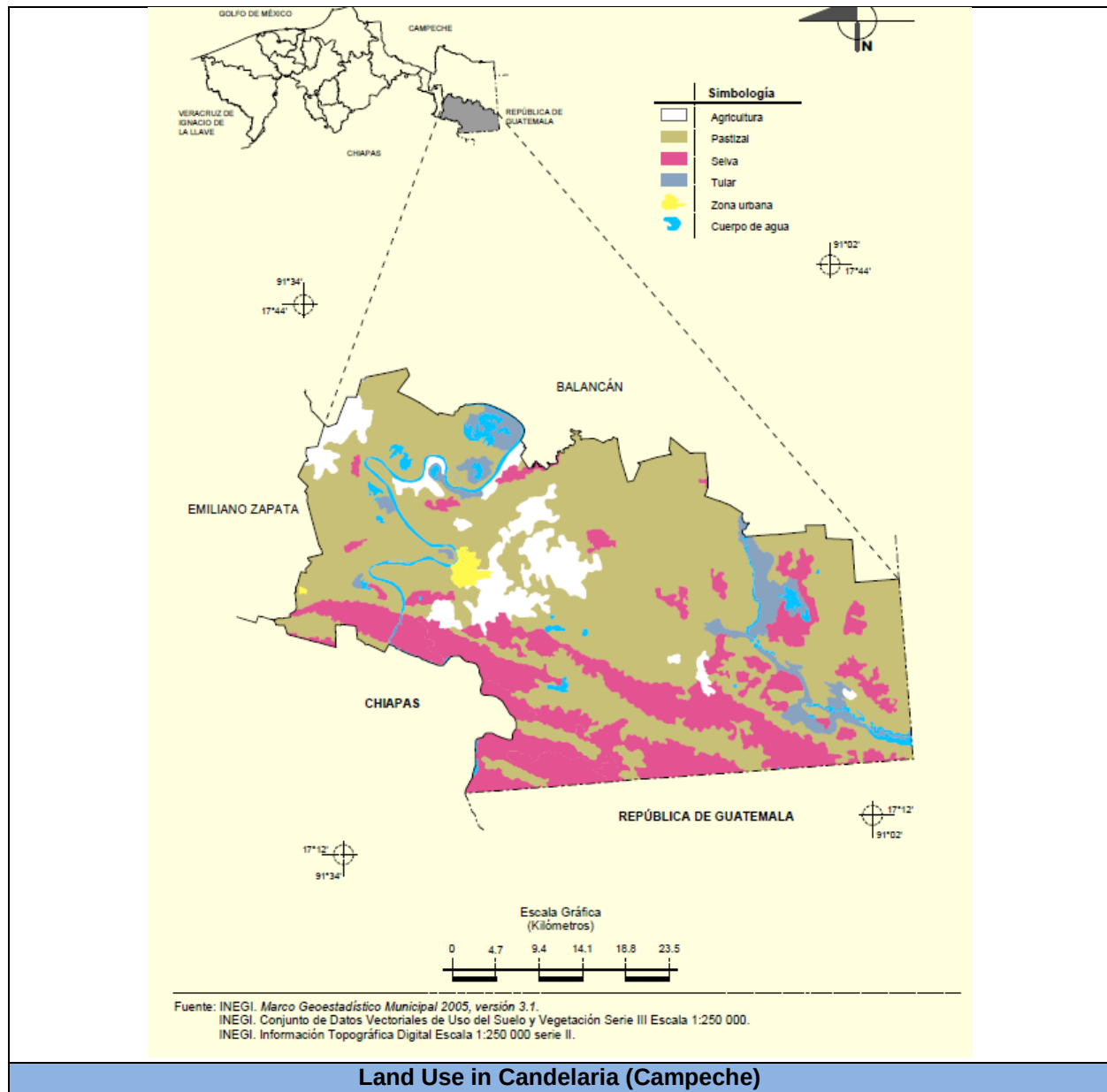
Table 12: Land use map in the municipalities where the project area included in the first phase of the grouped project is located¹¹⁹

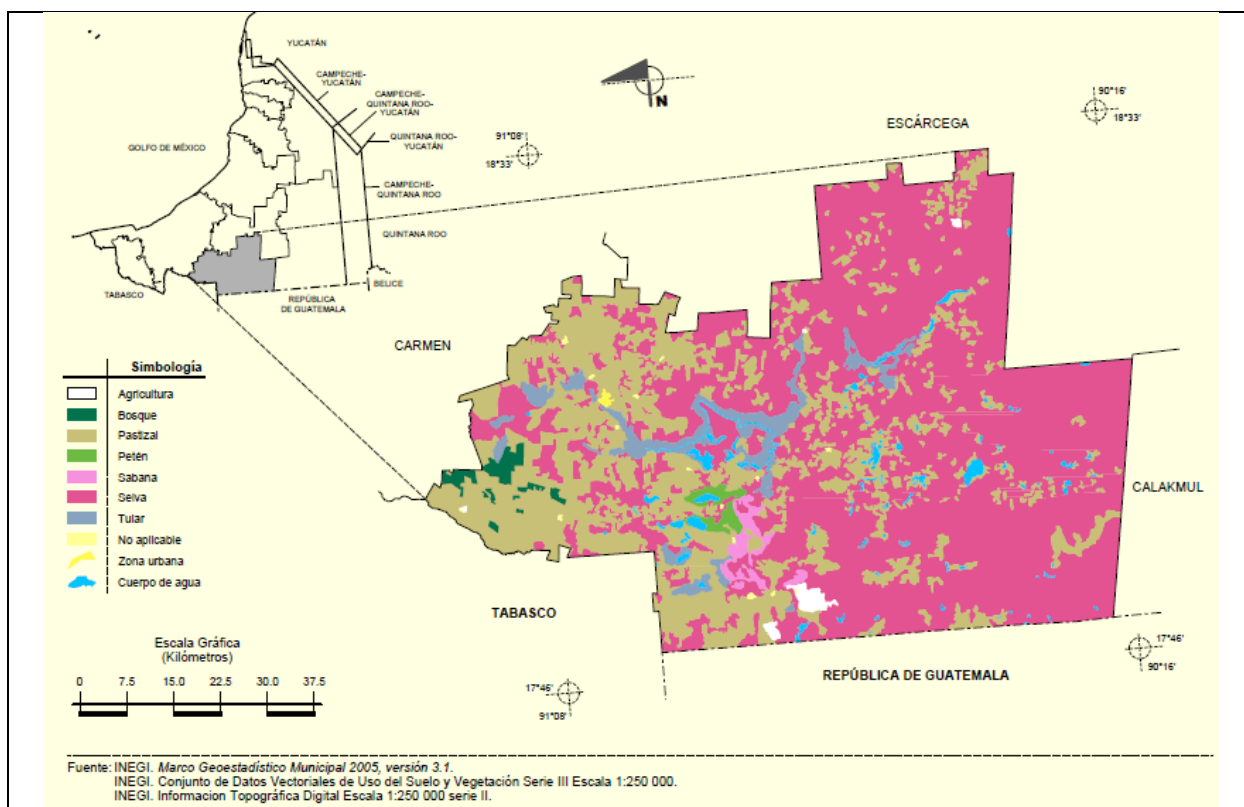
Land use in Balancan (Tabasco)	Land use in Huimanguillo (Tabasco)
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¹¹⁹Source of maps presented can be found in [Supporting documents\Land Use]

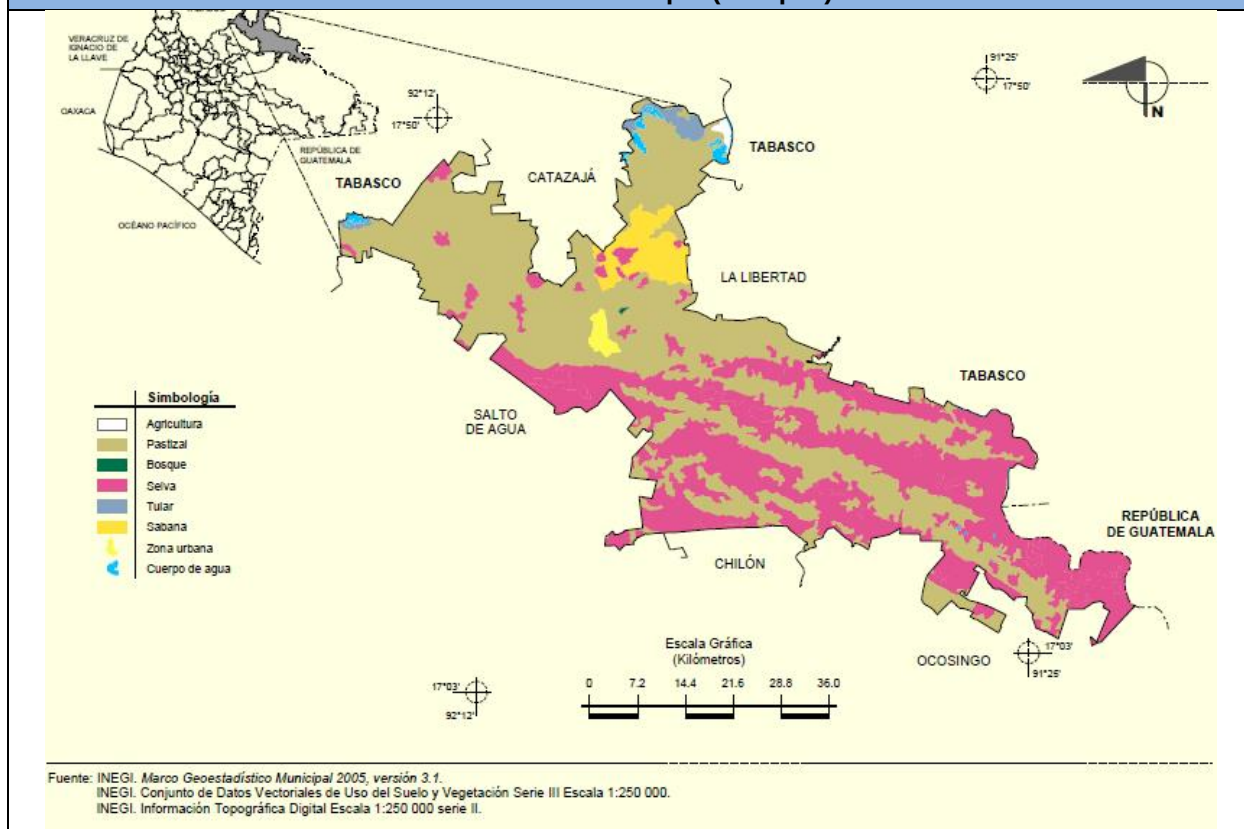


Land use in Tenosique (Tabasco)





Land Use in Palenque (Chiapas)



3.3.2 Leakage due to displacement of agriculture activities

In the case of Huimanguillo, the company that owned the citrus crops was liquidated and therefore is not expected to establish crops in other areas, meaning no leakage will be generated.

Given the explanation above, the project scenario does not consider likely the displacement of agricultural activities outside the project boundary, so the leakage emission is accounted as zero, given that non-decreasing carbon stocks (biomass and SOC) are expected from lands outside the project boundary associated with those activities.

3.4 Estimated Net GHG Emission Reductions and Removals

According to the “AR-ACM0003 A/R Large-scale Consolidated Methodology: Afforestation and reforestation of lands except wetlands Version 02.0”: *If biomass distribution over the project area is not homogeneous, stratification should be carried out to improve the precision of biomass estimation. Different stratifications may be appropriate for the baseline and project scenarios in order to achieve optimal precision of estimation of net GHG removals by sinks. In particular:*

- a) *For baseline net GHG removals by sinks, it is usually sufficient to stratify the area according to major vegetation types and their crown cover and/or land use types;* In the case of project area of the first instance, there are two major vegetation type that consists in grassland with little to no baseline vegetation existing within the actual planting area and citrus plantation.
- b) *For actual net GHG removals by sinks the stratification for ex ante estimations is based on the project planting/management plan.* In the case of project area of the first instance, stratification included the growth quality, the year of establishment and the precipitation range (Table 13).

Table 13: Stratification for ex ante actual net GHG removals by sinks of the first instance of the grouped project

Strata	Year of establishment	Area (ha)	Description
1.1	2013	424.14	Growth quality ¹²⁰ : “Excelente Semilla” Precipitation: >1,600 mm
1.2	2014	125.02	
1.3	2016	591.27	
1.4	2017	163.21	
2.1	2014	1052.15	Growth quality: “Alto”
2.2	2015	1145.84	
3.1	2013	377.72	Growth quality: “Excelente Semilla” Precipitation: 1000-1,600 mm
3.2	2014	26.92	
3.3	2017	105.69	

Estimating carbon stock in trees at a point in time:

To estimate the carbon stock in tree biomass at a point in time, the following tool was used: “*Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities AR-TOOL14*”

¹²⁰ More information about growth quality models can be found in 4.3.1.1

Version 04.1". The method "b) *Estimation by modelling of tree growth and stand development*" was used for ex-ante estimations. The estimation method is explained below.

- *Step 1: Volume estimation*

Volume estimation depending on diameter and height

The volume estimation per tree depending on diameter and height is found using the Tamarit equation (Tamarit, 2013)¹²¹:

$$V = 0.000059 * DBH^{1.866203} H^{0.932461}$$

V	=	Tree volume; m ³
DBH	=	Diameter at Breast Height; cm
H	=	Total height; m

Each year, the project proponent establishes permanent plots in the new areas planted and monitors the permanent plots already established (see section 4.3 for more details on the permanent plot measurements). The Tamarit equation is used to find the volume of all the trees of each plot. Subsequently,

¹²¹ See [Supporting documents/Estimations/REPORT OF VALIDATION_ecuacion volumen]

the volume of all the trees in each plot is summed to calculate the volume per plot and to extrapolate the volume per hectare.

Volume estimation depending on diameter and height

With the data per hectare (volume, diameter, height, age) of all the plots established, a set of growth model equations was adjusted by the project proponent following the steps described below¹²²:

- Adjustment of a statistical model that represents the growth in the diameter at breast height (DBH) and year (t) of the plantation. The equation adjusted was based on the model presented by the article "Tablas de rendimiento de teca para el estado de Campeche"¹²³:

$$X = Ae^{\frac{B}{x^c}}$$

Where:

- X = Diameter at breast height (DBH) or height (data from the permanent plots¹²⁴)
- x = Age of the plantation
- A, B, C = Regression parameters

- The information of 62 lots was used. Each lot is modelled to obtain its equation, through the use of the non-linear regression module of the software SPSS.
- Afterwards, a set of equations is developed to divide the lot into growth categories according to the estimated size of the Teak trees at their cutting cycle (18 years¹²⁵).
- The growth model equations generated are corroborated using the information of additional lots (Figure 26).

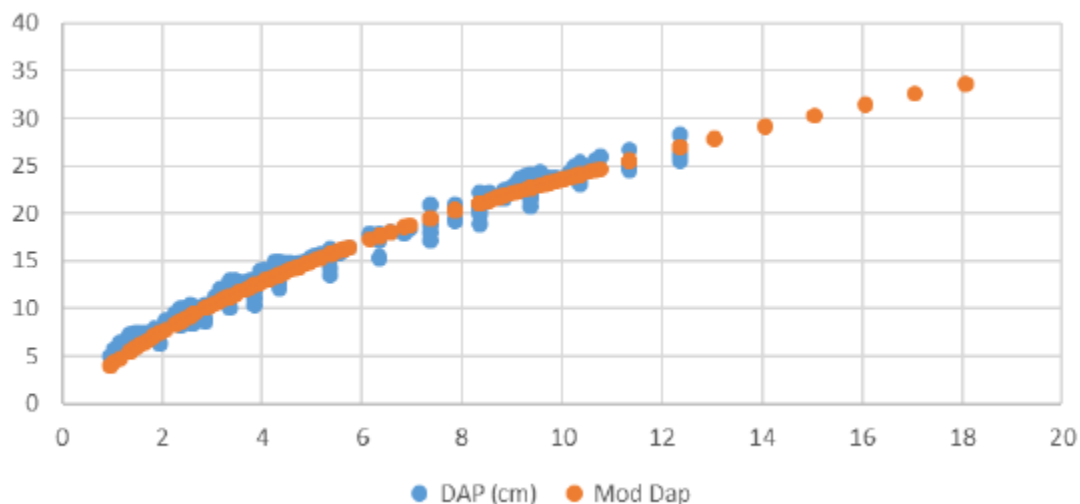


Figure 26: Comparison of observed points and predictions once regression parameters are obtained. Y axis: DBH; X axis: age; DAP: DBH; Mod Dap: DBH modelled.

¹²² A presentation with the description of the procedures to adjust the growth models is presented in [Supporting documents\Estimations\ Growth model explanation].

- All the curves adjusted are compared to define the growth range (Figure 27).

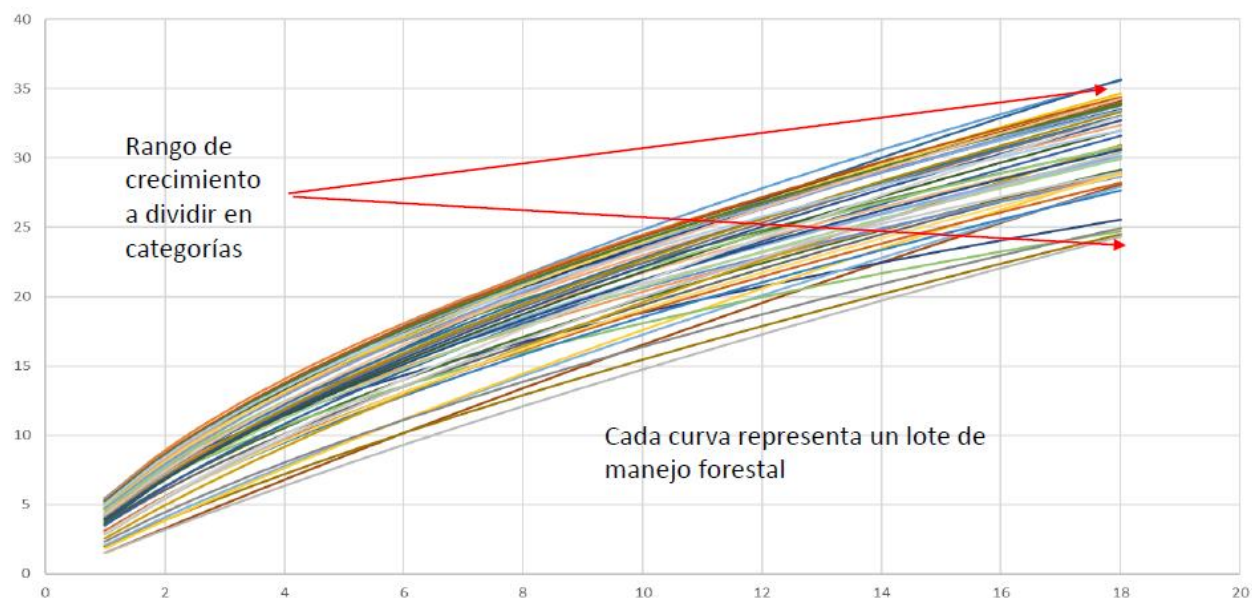


Figure 27: Model growth curves adjusted per lot.

Y axis: DBH; X axis: age; DAP: DBH; Mod Dap; DBH modelled.

- A general model of growth and five specific models with different growth rates were generated for both the diameter and height, and the volume obtained with the Tamarit equation. Using these models, a growth chart was made to present the three parameters (Diameter, Height and Volume) (Figure 30).

Edad	GRAL	BAJO	MEDIO	ALTO	EXS	EXC
1	4.0	3.2	3.7	4.0	4.3	5.1
2	7.2	5.7	6.6	7.2	7.7	9.1
3	9.8	7.8	9.1	9.9	10.7	12.6
4	12.2	9.7	11.4	12.3	13.2	15.6
5	14.4	11.4	13.4	14.4	15.6	18.4
6	16.4	13.0	15.2	16.5	17.8	20.9
7	18.3	14.5	17.0	18.3	19.8	23.3
8	20.0	15.9	18.6	20.1	21.7	25.6
9	21.7	17.2	20.2	21.8	23.5	27.7
10	23.3	18.5	21.6	23.4	25.2	29.7
11	24.8	19.7	23.0	24.9	26.9	31.7
12	26.3	20.9	24.4	26.3	28.4	33.5
13	27.7	22.0	25.7	27.8	30.0	35.3
14	29.0	23.0	27.0	29.1	31.4	37.0
15	30.3	24.1	28.2	30.4	32.8	38.7
16	31.6	25.1	29.3	31.7	34.2	40.3
17	32.8	26.1	30.5	32.9	35.5	41.9
18	34.0	27.0	31.6	34.1	36.8	43.4

Figure 28: Growth chart for DBH¹²⁶

¹²³ Article presented as supporting document [Supporting documents\Estimations\Tablas rendimiento Teca p Campeche].

¹²⁴ The average measurements are used at the permanent plot level.

¹²⁵ Cutting cycle according to the project activity business plan.

¹²⁶ Edad: age; GRAL: general model; BAJO: low growth; MEDIO: medium growth; ALTO: high growth; EXS: excellent growth for trees established using seeds; EXC: excellent growth for trees established using clones.

From the results of the measurements of the permanent plots during 2013-2017, it was concluded that, in general, the plantations established since 2013 have been growing at high yields, with most plots being catalogued as 'Excellent Seed' and 'Excellent Clone'¹²⁷. However, AGSA has recommended against cataloguing any site as 'Excellent Clone' because the plots are young, and their performance can diminish with age. Therefore, two growth qualities of volume-by-age data were used: 'Excellent Seed' and 'High'.

- *Step 2: Biomass estimation*

The estimation of tree biomass was calculated according to equation 5 Appendix 1 of the AR-TOOL14:

$$b_{TREE} = [V_{TREE} \times D \times BEF_2] \times (1 + R)$$

b_{TREE}	=	Mean tree biomass per hectare in the tree biomass estimation strata; t d.m. ha ⁻¹
V_{tree}	=	Mean tree volume per hectare in the tree biomass estimation strata; m ³ ha ⁻¹
D	=	Basic wood density; t m ⁻³
BEF_2	=	Biomass Expansion Factor; dimensionless
R	=	Root-to-shoot ratio; dimensionless

- *Step 3: mean carbon stock estimation and mean carbon stock in terms of CO₂e*

The estimation of the mean tree carbon per hectare in the tree biomass estimation strata was calculated according to equation 13 of the AR-TOOL14:

$$B_{tree} = A \times b_{tree}$$

B_{TREE}	=	Tree biomass in the tree biomass estimation strata; t d.m.
A	=	Sum of areas of the tree biomass estimation strata; ha
b_{TREE}	=	Mean tree biomass per hectare in the tree biomass estimation strata; t d.m. ha ⁻¹

The estimation of the mean carbon stock in trees within the tree biomass estimation strata was calculated according to equation 12 of the AR-TOOL14:

$$C_{TREE} = \frac{44}{12} \times C_{tree}$$

C_{TREE}	=	Carbon stock in trees in the tree biomass estimation strata; t CO ₂ e
CF_{TREE}	=	Carbon fraction of tree biomass; t C (t d.m.) ⁻¹
B_{TREE}	=	Tree biomass in the tree biomass estimation strata; t d.m.

¹²⁷ See supporting document [Supporting document/Estimations/Growth_model – Excel sheet lotes_calificacion]

Table 14. Parameters used for the estimation of tree biomass and mean carbon stock.

Parameter	Symbol	Value	Source
Basic wood density (t m ⁻³)	D	0.59	Rodríguez Anda, Fuentes T., & Silva Guzmán (2012) ¹²⁸
Biomass Expansion Factor (dimensionless)	BEF_2	1.50	IPCC (2003) ¹²⁹
Root-to-shoot ratio (dimensionless)	R	0.37	IPCC (2006) ¹³⁰
Carbon fraction of tree biomass; t C (t d.m.) ⁻¹	CF_{TREE}	0.47	

$$C_{tree(tCO_2e)} = \frac{44}{12} \times C_{tree}$$

- *Step 4: dead wood*

Estimations were done in accordance with the AR -TOOL 12 “Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities version 03.1”. Values of the conservative default-factors expressing carbon stock in dead wood as a percentage of carbon stock in tree biomass were selected according to the guidance provided in the methodological tool.

Conservative default-factor based method for estimation of carbon stock in dead wood

The project proponent will not make sampling-based measurements to estimate carbon stock in dead wood for all strata to which this default method is applied. The carbon stock in dead wood was estimated as indicated in equation 9 of the tool, using the default values presented in Table 15:

$$C_{DW,i,t} = C_{TREE,i,t} \times DF_{DW}$$

Where:

$C_{DW,i,t}$	= Carbon stock in dead wood in stratum i at a given point of time in year t; t CO ₂ e
$C_{TREE,i,t}$	= Carbon stock in trees biomass in stratum i at a point of time in year t. as calculated in the tool “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities”; t CO ₂ e

¹²⁸ See supporting folder [Supporting documents\Estimations\Wood density]. The wood density used is the average value found in the AGSA plantations (Rodríguez et al 2012). The value is supported by other findings in teak plantations in Costa Rica (Serrano et al_Pag 104).

¹²⁹ IPCC 2003. “Good Practice Guidance for LULUCF”. The BEF value for Tropical Climatic Zone and Broadleaf Forest Type was used. Table 3A.1.10 of Annex 3A.1.

¹³⁰ IPCC, 2006. Table 4.3. http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_04_Ch4_Forest_Land.pdf

DF_{DW}	=	Conservative default factor expressing carbon stock in dead wood as a percentage of carbon stock in tree biomass; per cent
i	=	1. 2. 3. ... biomass estimation strata within the project boundary
t	=	1. 2. 3. ... years elapsed since the start of the A/R project activity

Step 5: Litter

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 version 03.1”. Values of the conservative default-factors expressing carbon stock in litter as a percentage of carbon stock in tree biomass were selected according to the guidance provided in the methodological tool.

Conservative default-factor based method for estimation of carbon stock in litter (CLI)

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 version 03.0”. For all strata to which this default method is applied, the carbon stock in litter will be estimated as is indicated in equation 15 of the tool, using the default values presented in Table 15:

$$C_{LI,i,t} = C_{TREE,i,t} \times DF_{LI}$$

Where:

$C_{LI,i,t}$	=	Carbon stock in litter in stratum i at a given point of time in year t; t CO ₂ e
$C_{TREE,i,t}$	=	Carbon stock in trees biomass in stratum i at a point of time in year t. as calculated in tool “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities”; t CO ₂ e
DF_{LI}	=	Conservative default factor expressing carbon stock in litter as a percentage of carbon stock in tree biomass; percent
i	=	1. 2. 3. ... biomass estimation strata within the project boundary
t	=	1. 2. 3. ... years elapsed since the start of the A/R project activity

Table 15. Conservative default factor expressing carbon stock in dead wood and litter.

Parameters	Symbol	Value (%)	Comments
Conservative default factor expressing carbon stock in dead wood as a DW percentage of carbon stock in tree biomass.	DF_{DW}	1	Biome: tropical Elevation: <2,000m Precipitation 1000 - 1,600 ¹³¹ mm-yr ⁻¹
		6	Biome: tropical Elevation: <2,000m

¹³¹The value of 1% was applied to areas located in Campeche (strata 3) as the precipitation is less than 1,600 mm. See [Supporting documents\Climate_project_area]

Parameters	Symbol	Value (%)	Comments
			Precipitation >1,600 mm·yr ⁻¹¹³²
Default factor for the relationship between carbon stock in litter and carbon stock in living trees.	DF _{LI}	1	Biome: tropical Elevation: <2,000m Precipitation 1000 -1,600 mm·yr ⁻¹

- Step 6: carbon stock in trees at a point of time

Change in the carbon stocks in the selected carbon pools in the year t were calculated according to the AR-ACM0003 methodology:

$$\Delta C_{P,t} = \Delta C_{TREE_PROJ,t} + \Delta C_{SHRUB_PROJ,t} + \Delta C_{DW_PROJ,t} + \Delta C_{LI_PROJ,t}$$

- Where:

$\Delta C_{P,t}$	=	Change in the carbon stocks in project, occurring in the selected carbon pools. in year t ; t CO ₂ -e
$\Delta C_{TREE_PROJ,t}$	=	Change in carbon stock in tree biomass in project in year t . as estimated in the tool “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities”; t CO ₂ -e
$\Delta C_{SHRUB_PROJ,t}$	=	Change in carbon stock in shrub biomass in project in year t . as estimated in the tool “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities”; t CO ₂ -e
$\Delta C_{DW_PROJ,t}$	=	Change in carbon stock in dead wood in project in year t . 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 CO ₂ -e
$\Delta C_{LI_PROJ,t}$	=	Change in carbon stock in litter in project in year t . 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 CO ₂ -e

According to equation 5 of the methodology AR-ACM0003 v2.0, net anthropogenic GHG removals by sinks shall be calculated as follows:

$$\Delta C_{AR-CDM,t} = \Delta C_{ACTUAL,t} - \Delta C_{BSL,t} - LK_t$$

Where:

$\Delta C_{AR-CDM,t}$	=	Net anthropogenic GHG removals by sinks. in year t ; t CO ₂ -e
$\Delta C_{ACTUAL,t}$	=	Actual net GHG removals by sinks. in year t ; t CO ₂ -e

¹³²The value of 6% was applied to areas located in Chiapas and Tabasco (Strata 1 and 2) as the precipitation is bigger than 1,600 mm. See [Supporting documents\Climate_project_area]

$\Delta C_{BSL,t}$ = Baseline net GHG removals by sinks. in year t; t CO₂-e

LK_t = GHG emissions due to leakage. in year t; t CO₂-e

LK_t can be considered as 0 according to section 5.3, 5.4 and 5.5. Then, $\Delta C_{AR-CDM,t} = \Delta C_{ACTUAL,t} - \Delta C_{BSL,t}$

The period over which the long-term average GHG benefit is calculated is 36 years. The total GHG benefit of the first instance calculated as the sum of stock changes along the 36-year period is 1,619,592 tCO₂e (see Excel file —180716_Ex_ante_estimations).

Year	Estimated baseline emissions or removals (tCO ₂ e)	Estimated project emissions or removals (tCO ₂ e)	Estimated leakage emissions (tCO ₂ e)	Estimated net GHG emission reductions or removals (tCO ₂ e)
2012	0	111,492	0	111,492
2013	0	11,713	0	11,713
2014	0	-109,606	0	-109,606
2015	0	34,771	0	34,771
2016	0	62,162	0	62,162
2017	0	105,218	0	105,218
2018	0	110,618	0	110,618
2019	0	142,854	0	142,854
2020	0	99,456	0	99,456
2021	0	108,992	0	108,992
2022	0	134,574	0	134,574
2023	0	28,360	0	28,360
2024	0	47,179	0	47,179
2025	0	73,906	0	73,906
2026	0	71,760	0	71,760
2027	0	115,568	0	115,568
2028	0	156,090	0	156,090
2029	0	157,374	0	157,374
2030	0	157,109	0	157,109
2031	0	-320,592	0	-320,592
2032	0	-418,661	0	-418,661
2033	0	-398,670	0	-398,670
2034	0	-285,041	0	-285,041
2035	0	-86,094	0	-86,094
2036	0	105,218	0	105,218
2037	0	110,618	0	110,618
2038	0	142,854	0	142,854
2039	0	99,456	0	99,456
2040	0	108,992	0	108,992
2041	0	134,574	0	134,574
2042	0	28,360	0	28,360
2043	0	47,179	0	47,179

Year	Estimated baseline emissions or removals (tCO ₂ e)	Estimated project emissions or removals (tCO ₂ e)	Estimated leakage emissions (tCO ₂ e)	Estimated net GHG emission reductions or removals (tCO ₂ e)
2044	0	73,906	0	73,906
2045	0	71,760	0	71,760
2046	0	115,568	0	115,568
2047	0	156,090	0	156,090
2048	0	157,374	0	157,374
2049	0	157,109	0	157,109
Total	0	1,619,592	0	1,619,592

4 MONITORING

4.1 Data and Parameters Available at Validation

Data / Parameter	Volume model
Data unit	m ³
Description	Model to estimate volume of trees on the function of their diameter at breast height (DBH) and height.
Source of data	Tamarit, 2013 ¹³³
Value applied	$V = 0.000059 \cdot DBH^{1.866203} \cdot H^{0.932461}$
Justification of choice of data or description of measurement methods and procedures applied	The above-ground tree biomass is calculated using the Biomass Expansion Factor (BEF) and wood density in connection with the volume data. The model was adjusted with data of AGSA plantations from the same site of the project area. For ex-post estimates, DBH and height data measured between 2013 and 2017 were used.
Purpose of data	Estimation of GHG Emission Reductions and Removals.
Comments	NA
Data / Parameter	Wood density
Data unit	t m ⁻³
Description	Basic density of specific gravity used to estimate stem biomass.
Source of data	Rodríguez Anda, Fuentes T., & Silva Guzmán (2011) ¹³⁴
Value applied	0.59

¹³³ Tamarit, J. (2013). Doctoral Thesis. Volume calculation, growth and timber yield and operative inventory for *Tectona grandis* in southeastern Mexico. Montecillo.

¹³⁴ Rodríguez Anda, R., Fuentes T., F., & Silva Guzmán, J. (2011). Technological study for the evaluation and use of *Tectona grandis* wood from thinning of commercial forest plantations in the state of Campeche, as a support for technological and market innovation.

Justification of choice of data or description of measurement methods and procedures applied	The above-ground tree biomass is calculated using the BEF and wood density in connection to the volume data.
Purpose of data	Estimation of GHG Emission Reductions and Removals.
Comments	NA

Data / Parameter	Biomass Expansion Factor (BEF)
Data unit	Dimensionless
Description	Ratio of aboveground oven-dry biomass to oven-dry biomass of the stem.
Source of data	(IPCC, 2003)
Value applied	1.5
Justification of choice of data or description of measurement methods and procedures applied	The above-ground tree biomass is calculated using the BEF and wood density in connection with the volume data. The BEF value for Tropical Climatic Zone and Broadleaf Forest Type was used.
Purpose of data	Estimation of GHG Emission Reductions and Removals.
Comments	NA

Data / Parameter	Root-Shoot-Ratio (R)
Data unit	Dimensionless
Description	Ratio of the weight of the roots to the weight of the top of the tree. Used for belowground tree biomass estimation.
Source of data	IPCC (2006) ¹³⁵
Value applied	0,37
Justification of choice of data or description of measurement methods and procedures applied	Belowground biomass is usually estimated with this factor, as belowground sampling is ecologically destructive and expensive.
Purpose of data	Estimation of GHG Emission Reductions and Removals.
Comments	NA

Data / Parameter	Carbon Fraction of dry matter (CF)
Data unit	tC t d.m. ⁻¹

¹³⁵ IPCC. (2006). IPCC Guidelines for National Greenhouse Gas Inventories volume 4: Agriculture, Forestry and Other Land Use.

Description	Biomass proportion corresponding to carbon. CF is used to convert biomass to carbon.
Source of data	Table 4.3 of IPCC (2006): "Good Practice Guidance for LULUCF"
Value applied	0.47
Justification of choice of data or description of measurement methods and procedures applied	The default value from IPCC.
Purpose of data	Estimation of GHG Emission Reductions and Removals.
Comments	NA

Data / Parameter	DF _{DW}
Data unit	%
Description	Conservative default factor expressing carbon stock in dead wood as a DW percentage of carbon stock in tree biomass.
Source of data	AR-TOOL12 "Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities, Version 03.1, Section 8.
Value applied	Elevation < 2,000 m, and precipitation > 1,600 mm·yr ⁻¹ = 6 Elevation < 2,000 m, and precipitation 1000 - 1,600 mm·yr ⁻¹ = 1
Justification of choice of data or description of measurement methods and procedures applied	Default value for Tropical Biome.
Purpose of data	Estimation of GHG Emission Reductions and Removals.
Comments	NA

Data / Parameter	DF _{LI}
Data unit	%
Description	Default factor for the relationship between carbon stock in litter and carbon stock in living trees.
Source of data	AR-TOOL12 "Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities", Version 03.1, Section 8.
Value applied	1% and 6%
Justification of choice of data or description of measurement methods and procedures applied	1%: Default value for Tropical Biome, elevation < 2,000 m, and precipitation between 1000 and 1,600 mm·yr ⁻¹ . 6%: Default value for Tropical Biome, elevation < 2,000 m, and precipitation up to 1,600 mm·yr ⁻¹ .

Purpose of data	Estimation of GHG Emission Reductions and Removals.
Comments	NA

4.2 Data and Parameters Monitored

Data / Parameter	A
Data unit	Ha
Description	Project Area (planted area).
Source of data	Survey databases of each polygon that is part of the project.
Description of measurement methods and procedures to be applied	Field measurement: the area shall be delineated either on the ground using GPS or from geo-referenced remote sensing data.
Justification of choice of data or description of measurement methods and procedures applied	NA
Frequency of monitoring/recording	At the beginning of site preparation or at the final establishment of the project.
Value applied	Ex-post.
Monitoring equipment	GPS equipment (precision 1- 5 m) and Remote Sensing data.
QA/QC procedures to be applied	See section 4.3 Procedures for internal auditing and QA/QC.
Purpose of data	Calculation of project emissions.
Calculation method	Measurement.
Comments	NA

Data / Parameter	A_i
Data unit	Ha
Description	Area of stratum i
Source of data	Monitoring of stratum and stand boundaries is done employing Geographical Information Systems (GIS) that allow the integration of data from different sources (including GPS coordinates and Remote Sensing data).

Description of measurement methods and procedures to be applied	Field measurement: the area shall be delineated either on the ground using GPS or from geo-referenced remote sensing data.
Frequency of monitoring/recording	At the beginning of site preparation.
Value applied	Ex-post.
Monitoring equipment	GPS equipment (precision 1- 5 m) and Remote Sensing data.
QA/QC procedures to be applied	See section 4.3 Procedures for internal auditing and QA/QC.
Purpose of data	Calculation of project emissions.
Calculation method	Measurement.
Comments	The stratification for ex-post estimations is based on the actual implementation of the project planting/management plan. It may even be necessary to evaluate the possibility of re-stratifying the project boundary, according to the development of the stand models, as it would enable the merging of several strata in order to optimize costs and improve outcomes in forest inventories.

Data / Parameter	N
Data unit	Dimensionless
Description	Number of plots to be established in the project area.
Source of data	Estimation.
Description of measurement methods and procedures to be applied	This value will be estimated based on a pre-sampling developed in the project area before monitoring.
Frequency of monitoring/recording	Each time a verification is conducted.
Value applied	Ex-post.
Monitoring equipment	NA

QA/QC procedures to be applied	Before the monitoring report, the error estimation will be carried out with the last measurements to estimate if further plots must be established.
Purpose of data	Estimate the number of plots needed for complying with a sampling error less than 10%.
Calculation method	See section 4.3.2.1 Number of plots.
Comments	NA

Data / Parameter	n_i
Data unit	Dimensionless
Description	Number of plots to be established in each stratum.
Source of data	Estimation.
Description of measurement methods and procedures to be applied	This value will be estimated using the total number of plots and the area of each stratum.
Frequency of monitoring/recording	Each time a verification is conducted.
Value applied	Ex-post.
Monitoring equipment	NA
QA/QC procedures to be applied	In each forest management lot there should be at least 1 PPM per 25 hectares. In cases where the forest management lot has a discontinuous surface, with different soil or growth conditions, then another PPM will be added. However, not all cases of surface discontinuity will require a PPM in each discontinuous part. As the plantation progresses, the variance of the MPPs of each forest management lot is analyzed and the appropriate number of PPMs is adjusted for that lot.
Purpose of data	Estimation of the number of plots needed for each stratum for complying with a sampling error of less than 10%.
Calculation method	See section 4.3.2 Number of plots.
Comments	NA

Data / Parameter	Plot Location
------------------	---------------

Data unit	Lat/Long
Description	Localization of each sampling plot.
Source of data	Data field sampling.
Description of measurement methods and procedures to be applied	Measured with GPS.
Frequency of monitoring/recording	Each time a verification is conducted.
Value applied	NA
Monitoring equipment	GPS.
QA/QC procedures to be applied	NA
Purpose of data	Calculation of project emissions.
Calculation method	NA
Comments	Sample plot location is registered with a GPS and marked on the project map.

Data / Parameter	DBH
Data unit	Cm
Description	Diameter at Breast Height of the trees.
Source of data	Field measurements in sample plots.
Description of measurement methods and procedures to be applied	Typically measured 1.3 m above-ground. Measure all the trees above some minimum DBH in the permanent sample plots that result from the project activity.
Frequency of monitoring/recording	Each time a verification is conducted.
Value applied	Ex-post.
Monitoring equipment	Tape measure.
QA/QC procedures to be applied	Workers involved in field measurement work should be fully trained in field data collection. Field measurements shall be checked by a qualified person to correct any technical errors.

	Additionally, there is a forest auditor who is charged with giving an independent opinion on the quality of the information presented to investors of the company. This is done by randomly selecting 10% of the plots and using 10 trees from each of these plots. From this, a comparative report is issued to compare the information found by the auditor and that found by AGSA. If there are inconsistencies in the diameter data found in the software Mirasilv ¹³⁶ (APPENDIX 2: VERIFICATION OF CONSECUTIVE MEASUREMENTS), these are referred to the forest supervisor so that they can do a corresponding review in the field.
Purpose of data	Calculation of project emissions
Calculation method	See section 4.3.2 of the Monitoring Plan.
Comments	NA

Data / Parameter	H
Data unit	M
Description	Total height of trees.
Source of data	Field measurements in sample plots.
Description of measurement methods and procedures to be applied	Measure all the tree heights in the permanent sample plots that result in the project activity.
Frequency of monitoring/recording	Each time a verification is conducted.
Value applied	Ex-post.
Monitoring equipment	Clinometer, measuring tape.
QA/QC procedures to be applied	Workers involved in field measurement work should be fully trained in field data collection. Field measurements shall be checked by a qualified person to correct any technical errors. In the software used by the company (Mirasilv), there is a model to review successive measurements to verify the consistency of the recorded increments in diameter and height. This is the first review

¹³⁶ **Software Mirasilv:** It is an application dedicated to the management of arboreal information.

The system facilitates, through a standardized methodology, the establishment of temporary or permanent plots of growth of any shape and size, and for any forest species. It allows the creation of an individual database that facilitates the monitoring and comparison of tree growth. It also facilitates classification by site quality in reforestation programs, and compares the increase in volume, height and diameter, evaluated in different plantations systems.

	done in the process (APPENDIX 2: VERIFICATION OF CONSECUTIVE MEASUREMENTS). Once again, the forest auditor is charged with giving an independent opinion on the quality of the information presented to investors of the company. This is done by selecting in a random manner 10% of the plots. From each of these plots, 10 trees are used to create a comparative report for the information found by the auditor and that found by AGSA. If there are inconsistencies in the height data found by Mirasilv, these are referred to the forest supervisor so that they can do a corresponding review in the field (Appendix 4).
Purpose of data	Calculation of project emissions.
Calculation method	See section 4.3.2 of the Monitoring Plan.
Comments	NA

Data / Parameter	T
Data unit	Year
Description	Period elapsed between two successive estimations of carbon stock in trees and shrubs.
Source of data	Verification records.
Description of measurement methods and procedures to be applied	See Monitoring Plan
Frequency of monitoring/recording	Each time a verification is conducted.
Value applied	Ex-post.
Monitoring equipment	NA
QA/QC procedures to be applied	NA
Purpose of data	Calculation of project emissions.
Calculation method	$T = t_2 - t_1$
Comments	If the two successive estimations of carbon stock in trees are carried out at different points of time in year t_2 and t_1 , (e.g. in the month of April in year t_1 and in the month of September in year t_2), then a fractional value is assigned to T.

4.3 Monitoring Plan

4.3.1 Verification of changes in carbon stocks in the pools selected

This monitoring plan provides guidance on monitoring and standard operational procedures for the ARR project activity. This monitoring plan fulfils the requirement that the project activity should have credible and accurate monitoring procedures in place to enable the evaluation of project performance and verification of the net anthropogenic GHG emission removals.

Only the above-ground biomass of trees established will be measured. Therefore, only the individual growth of trees will be monitored in permanent plots.

The carbon content below-ground (in dead wood and litter) attributable to project activities will not be monitored. These will be estimated by using default values and suggested methods using the tools “Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities” and “Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities”. Root-to-shoot ratio (R) will be used to estimate belowground biomass, given the above-ground measures.

4.3.1.1 Stratification

The data sampling will be designed using strata defined for the project according to the planting date, the plots' quality qualification previously defined by AGSA, and the success of growth¹³⁷:

AGSA has a 5-level classification of growth: low, medium, high, excellent seed and excellent clone. This classification corresponds to values of individual trees, which, at 18 years old, have reached 27, 32, 34, 37 and 43 cm in diameter and 17, 20, 22, 26 and 28 m in height (for low, medium, high, excellent seed and excellent clone respectively). These levels were obtained by analyzing the growth tendencies of established plantations, which revealed five growth curves with relation to diameter-height. The growth of the established plots in the different lots was compared with the generated growth curves to estimate the quality of growth.

The strata will be monitored to identify different growth patterns in each stratum that can lead to a unification between strata or a more detailed stratification. An annual update of the project area will be implemented based on the quality qualification of stands that is used by AGSA, so allowing for permanent control and monitoring of the area. The process seeks to identify if the stratums defined in each monitoring period need to be changed. According to changes in the quality qualification and the accumulation of carbon during each monitoring period, a new stratification based on biomass growth can be created. The findings from each monitoring period will allow a re-stratification for the next one, within the following parameters:

- Age
- Quality qualification
- Silviculture management
- Carbon stock
- Cost-effectiveness of the monitoring process
- Disturbances (plagues, fire, pathologies, etc.)

¹³⁷ [Supporting documents/Estimations/Growth_model].

4.3.2 Establishment of permanent plots¹³⁸

The activities related to the establishment and measurement of permanent monitoring plots (PPMs) are then defined to evaluate the development of the plantation ¹³⁹.

Responsible

It is the responsibility of the Production Manager, the Forest Manager, the Chief of Quality and the Chief of Forestry Maintenance to ensure that all the guidelines established in this procedure are properly complied with by plot measurement teams.

Location in the topographic map

Each delimited forest management lot is recorded in the general AGSA plan, including its total area. Furthermore, each plot of forest management or MIRA¹⁴⁰ lot has a record that includes the location, total area, species planted and date of planting.

Location of permanent plots at the project level

Depending on the total area of the forest management plot, the number of permanent monitoring plots (PPM) to be established is determined. The criteria for determining how many PPMs are established in each forest management lot are as follows:

- In each forest management lot there should be at least 1 PPM per 25 hectares.
- In cases where the forest management lot has a discontinuous surface, with different soil or growth conditions, then another PPM will be added. However, not all cases of surface discontinuity will require a PPM in each discontinuous part.
- As the plantation progresses, the variance of the MPPs of each forest management lot is analyzed and the appropriate number of PPMs is adjusted for that lot.
- The location of each permanent plot must be determined on a map. For each plot, the northwest corner is selected as a reference point to find its location.

Size and shape of plots:

For forest lots in which planting began with 1,250 trees per hectare, permanent plots of 20 m by 40 m have been established, resulting in 800 m², which contained 100 trees at the start. For forest lots in which planting

¹³⁸ More detailed information about the establishment of the monitoring plots is found as a supporting document in [Supporting documents/Estimations/Plot_establishment].

¹³⁹ Activities for the establishment of PPM were made taking into account the guidance provided by CATIE (2003). Guide for the Establishment and Measurement of Plots for the Monitoring and Evaluation of Tree Growth in Research and Reforestation Programs with the MIRA System Methodology. Luis A. Ugalde Arias. Tropical Agronomic Research and Teaching Center (CATIE), Costa Rica, 2003.

¹⁴⁰ Plots of forest management (Plots MIRA) are the minimum units of forest management which correspond to sections of a production order. In some cases this will be equal to a production order, with the same species, approximately the same age and with the same rate of growth.

started with 816 trees per hectare, permanent plots of 35 m by 35 m have been established, also containing 100 trees in a 1,225 m² area.

All the plots monitored during the period 2013-2017 have an area of 1,225 m².

Establishment of the plot in the field

In the field, the reference point of each PPM is located with the geographical coordinates that correspond to the tree 'number one' in the plot. A pole is stuck in each corner of the measuring plot and the forest management lot or MIRA lot is marked, as well as the plot number in the post located in the northwest corner of that parcel.

To identify each PPM within each site, each plot of forest management is assigned a consecutive number and consequently, within each plot of forest management, consecutive numbering of the PPMs is used.

From the reference tree located in the northwest corner, there are 10 trees to the east and 10 trees to the south, which are numbered as shown in Figure 29:

NORTE									
Oeste									Este
1	2	3	4	5	6	7	8	9	10
20	19	18	17	16	15	14	13	12	11
21	22	23	24	25	26	27	28	29	30
40	39	38	37	36	35	34	33	32	31
41	42	43	44	45	46	47	48	49	50
60	59	58	57	56	55	54	53	52	51
61	62	63	64	65	66	67	68	69	70
80	79	78	77	76	75	74	73	72	71
81	82	83	84	85	86	87	88	89	90
10	99	98	97	96	95	94	93	92	91
0									
Oeste									Este
SUR									

Figure 29: Numbering of trees within the PPM

Measuring of trees

The height and diameter of each of the trees in the plot are measured. With this information, the number of trees in it is determined during the development of the plantation. It is then possible to determine site quality based on growth curves as a function of age.

The data of diameter and height taken in the field should be recorded in the Format MEASUREMENT OF STANDING TREES (APPENDIX 1), generated through MiraSilv software. The forest catcher oversees entering the measurements to Mirasilv.

Measurement of diameter

This is measured at 1.30 m high (chest height), measured from the base of the tree. Here, the diameter of the tree is measured with a diameter tape.

When using the standard tape measure graduated in centimeters and millimeters, the measurement given is the perimeter. The diameter is calculated by dividing the measured value by π (pi). Steel or nylon reinforced plastic tape will be used to avoid damage to the tape that may cause errors in obtaining data (Figure 30). The measurement of diameters is performed according to the indications in Figure 31.



Figure 30: Measuring the diameter with a measuring tape

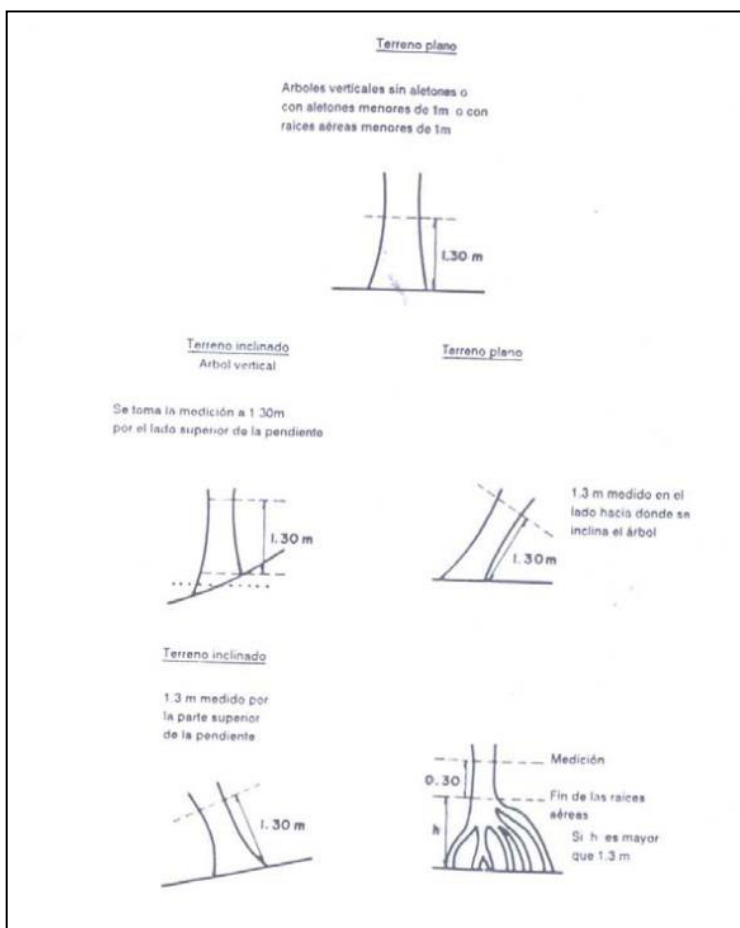


Figure 31: Measuring the diameter according to the inclination of the shaft with respect to the surface

Height Measurement

For the commercial case, two readings of tree height are taken. The first one is taken from the top, where the tree trunk reaches a minimum of 10 cm in diameter, and the bottom reading is done at the base of the tree. Height measurements can be taken in two ways, depending on the measuring equipment used:

1. Measuring with a 15-meter-high bar: The person responsible for measuring stands in front of the tree to be measured. They place the bar next to the tree and extend it until the hook reaches the top of the tree. When reading the stamped bar, it is important to remember that the numbering starts at the top of the bar and goes down to the bottom. This instrument measures in meters, decimeters and centimeters. In the case of small trees that are less than 4 m in height, an aluminum tool of 4 or 5 m can be used (Figure 32).



Figure 32: Measuring with a stamped bar

2. Measuring with an electronic clinometer: For a single reading of the clinometer, the person responsible for the measurement must calibrate it according to their distance from the tree to be measured. This depends on the height of the tree, as the distance should always be greater than the height of the tree. Taking the readings from the treetop and the base of the tree, the clinometer reveals the height of the tree (Figure 33).



Figure 33: Measuring with a clinometer

Frequency and use of the data taken in PPMs

The plots are measured annually during the month of October. In addition to estimating the carbon sequestration of plantations, the information generated is used to document the effectiveness of the technology package, to incorporate appropriate adjustments to the management plan, to decide on the type of soils to be planted in the future, to anticipate thinning logistical needs and final harvests, as well as to have an updated financial projection of project productivity.

4.3.2.1 Number of plots

The number of plots required for measuring the variation within the project boundary and strata shall be estimated by using the CDM tool “A/R Methodological Tool” for “Calculation of the number of sample plots for measurements within A/R CDM project activities”.¹⁴¹

The number of plots to be established and measured will be estimated as follows:

Where:

N	Number of sample plots required for estimation of biomass stocks within the project boundary; dimensionless
I	Total number of strata within the project boundary
<i>l</i>	1, 2, 3, ... biomass stock estimation strata within the project boundary
N	Total number of possible sample plots within the project boundary (i.e. the sampling space or the population); dimensionless
<i>T</i>	Two-sided Student's t-value, at infinite degrees of freedom, for the required confidence level; dimensionless
<i>w_i</i>	Relative weight of the area of stratum <i>i</i> (i.e. the area of the stratum <i>i</i> divided by the project area); dimensionless
<i>s_i</i>	Estimated standard deviation of biomass stock in stratum <i>i</i> ; (t ha ⁻¹)
E	Acceptable margin of error in estimations of biomass stock within the project boundary; t d.m. (or t d.m. ha ⁻¹), i.e. in the units used for <i>s_i</i>

The number of plots to be established and measured will be estimated as follows:

$$n = \frac{N * t^2 * (\sum_{i=1}^I w_i * s_i)^2}{N * E^2 + t^2 * \sum_{i=1}^I w_i * s_i^2}$$

Where:

<i>n_i</i>	Number of sample plots allocated to stratum <i>i</i> ; dimensionless
N	Number of sample plots required for estimation of biomass stocks within the project boundary; dimensionless
<i>s_i</i>	Estimated standard deviation of biomass stock in stratum <i>I</i> (t ha ⁻¹)
I	Total number of strata within the project boundary
<i>l</i>	1, 2, 3, ... biomass stock estimation strata within the project boundary

4.3.2.2 Analysis of the monitored data and parameter

The data recorded in the forest inventory (DBH and height) will be the input for the volume model that will define the total biomass accumulated for the project at the time of monitoring.¹⁴²

For ex-post estimates, the default parameters and equations (sections 4.1 and 4.2) will be the same ones used for ex-ante estimations, unless better values exist at the verification time, always in compliance with

¹⁴¹ CDM “A/R Methodological Tool: Calculation of the number of sample plots for measurements within A/R CDM project activities” available at: <https://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-03-v2.1.0.pdf>

¹⁴² All the data proposed can be updated.

the AR tool for carbon stock estimation. See section 3.4 for ex-ante Net GHG Emission Reductions and Removals.

4.3.2.1 Procedures for internal auditing and QA/QC

AGSA will be responsible for the centralized documentation of all project planning and implementation. Quality assurance (QA) and quality check (QC) procedures will be implemented and the use of these procedures monitored to ensure that net anthropogenic GHG removals by sinks are measured and monitored precisely, and are credible, verifiable, and transparent.

- Training will be held for all relevant personnel on all data collection and analysis procedures.
- Steps will be taken to control mistakes in sampling and data analysis in order to develop a credible plan for measuring and monitoring carbon stock change in the project. The same procedures shall be used throughout the project lifetime to ensure continuity:
 - a) In the software used by the company (Mirasilv), there is a model which can review successive measurements of diameter and height to check their consistency. This is the first review that is done in the process (APPENDIX 2: VERIFICATION OF CONSECUTIVE MEASUREMENTS).
 - b) Furthermore, the forest auditor will issue a comparative report on the height of trees to provide investors with an independent opinion on the quality of the information. This will be based on measurements taken from 10 trees in a randomly-selected 10% of the land plots. If there are inconsistencies in the data with that of Mirasilv, a supervisor shall undertake a field-site revision of the data.

Field data collection

The staff involved in the measurement of carbon pools will be fully trained in field data collection and analysis. To verify that plots have been installed and the measurements taken correctly, a minimum of 10% of randomly selected plots will be re-measured by a supervisor with a team not involved in the initial measurement sampling.

The re-measurement data will be compared with the original measurement data. Any errors found will be corrected and recorded. The level of errors recorded will be calculated and reported using the following equation:

$$Error (\%) = \frac{|Estimate_1 - Estimate_2|}{Estimate_2}$$

The proper entry of data into the data analyses spreadsheets is required to produce reliable carbon estimates. Communication between all staff involved in measuring and analyzing data will be used to resolve any apparent anomalies before a final analysis of the monitoring data will be completed. If there are any problems with the monitoring plot data that cannot be resolved, the plot will not be used in the analysis. Expert judgment and comparison with independent data will be used to try and ensure that data results are in line with expectations. Additionally, field data will be reviewed by the crew leader of the monitoring team (Operational and management structure), further ensuring that the data and analysis are accurate.

Due to the long length of the project (36 years) and the speed at which technology is advancing, data archiving will be an essential component. Data will be archived in several forms. The data stored will be: data analysis and models, the final estimate of the amount of carbon sequestered, any GIS products, and the measuring and monitoring reports. Electronic copies of all data and reports will be updated periodically and converted to any new format required by future software or hardware. A project participant involved in the field measurements will be assigned to implement this updating. The data collected shall be archived for a period of at least two years after the end of the last crediting period of the project activity. The main activities to be developed for the QA/QC process are described in Table 16.

Table 16: Verification and checklist considered to guarantee the quality of the information gathered and its management

QC activity	Procedures
Check that assumptions and criteria for the selection of emission factors and other estimation parameters are documented.	• Cross-check descriptions of project activities, emission factors and other estimation parameters with information on source and sink categories and ensure that these are properly recorded and archived.
Check for transcription errors in data input and reference.	• Confirm that bibliographical data references are properly cited in the internal documentation. • Cross-check a sample of input data (either measurements or parameters used in calculations) for transcription errors.
Check that removals are calculated correctly.	• Reproduce a representative sample of removal calculations. • Selectively mimic complex model calculations with abbreviated calculations to judge relative accuracy.
Check that parameter and units are correctly recorded and that appropriate conversion factors are used.	• Check that units are properly labelled in calculation sheets. • Check that units are correctly carried through from the beginning to the end of calculations. • Check that conversion factors are correct. • Check that temporal and spatial adjustment factors are used correctly.
Check the integrity of database files.	• Confirm that the appropriate data processing steps are correctly represented in the database. • Confirm that data relationships are correctly represented in the database. • Ensure that data fields are properly labelled and have the correct design specifications. • Ensure that adequate documentation of database and model structure and operation are archived.
Check that the movement of inventory data among processing steps is correct.	• Check that removal data are correctly reported when preparing summaries. • Check that removal data are correctly transcribed between different intermediate products.
Check that uncertainties in removals are estimated or calculated correctly.	• Check that qualifications, assumptions and expert judgments are recorded. • Check that calculated uncertainties are complete and calculated correctly, following the methodology requirements.

QC activity	Procedures
Undertake review of internal documentation.	- Check that there is detailed internal documentation to support the estimates and to enable the reproduction of the emission, removal estimates. - Check that inventory data, supporting data, and inventory records are archived and stored to facilitate detailed review. - Check the integrity of any data archiving arrangements of outside organizations involved in inventory preparation.
Check time series consistency.	- Check for temporal consistency in time series input data for biomass estimation. - Check for consistency in the algorithm/method used for calculations throughout the time series.
Undertake completeness checks.	- Confirm that estimates are reported for all years. - Check that known data gaps that may result in incomplete emissions estimates are documented and treated in a conservative way.
Compare estimates to previous estimates.	Current inventory estimates should be compared to previous estimates, if available. If there are significant changes or departures from expected trends, re-check estimates and explain the difference.

Uncertainty assessment

The project follows the modalities and procedures for A/R project activities to estimate baseline net GHG removal by sinks, leakage, actual net GHG removal by sinks, and net anthropogenic removal by sinks.

Equation 15 of the *AR-TOOL 14* was used to calculate the uncertainty in tree volume. The uncertainty value is 7.48%¹⁴³, which implies a discount of 0% for the GHG removals of the current monitoring period.

Other elements of monitoring plan

The baseline is to be the continuation of economic activities that were taking place before the project start date, which are due to the historical use of the soil, and are unlikely to change. However, if in the course of the project it is decided to renew the Accreditation Period, the baseline must be reviewed to determine whether the baseline approach used is still valid, or if the conditions have changed due to changes in regulations and sector policies, or technical, environmental or market factors.

Verification of project emissions

The project will quantify and monitor the non-CO₂ GHG emissions resulting from any fire occurrences (forest fires) within the project boundary, whose accumulated area affected by such fires in a year is $\geq 5\%$ of the project area. These events will be monitored and the affected area will be recorded.

Emissions of non-CO₂ GHGs resulting from the loss of aboveground tree biomass due to fire will be calculated in each verification period by using: the aboveground biomass in trees of relevant strata

¹⁴³ [\[Supporting documents/Estimations/SamplingError&Uncertainty\]](#)

calculated in the previous verification, the default values for the combustion factor, the emission factors and the global warming potential.

4.3.2.1 Operational and management structure

The operational structure and responsibilities for the project are presented as a supporting document¹⁴⁴.

5 SAFEGUARDS

5.1 No Net Harm

Table 17 presents the identified impacts that could occur due to the activities of the project and their respective mitigation measures.

Table 17: Potential impacts of project activities

Activities	Environmental				Social		
	Flora and fauna	Soils	Air	Water	Health	Safety	Employment stability
Establishment of the nursery	√ (-)	√ (+)	√ (Θ)	√ (-)	√ (Θ)	√ (+)	√ (+)
Land preparation	√ (-)	√ (+)	√ (-)	√ (Θ)	√ (Θ)	√ (+)	√ (+)
Plantation	X	X	√ (+)	√ (+)	√ (-)	√ (+)	√ (+)
Maintenance							
Pruning	√ (-)	X	X	X	√ (-)	√ (+)	√ (+)
Thinning	√ (-)	√ (-)	√ (-)	X	√ (-)	√ (+)	√ (+)
Fertilization	X	√ (+)	X	X	√ (-)	√ (+)	√ (+)
Health	√ (-)	X	X	X	√ (-)	√ (+)	√ (+)
Fires	√ (-)	√ (+)	√ (-)	√ (Θ)	√ (-)	√ (+)	√ (+)
Exploitation							
Manual-chainsaw	√ (-)	√ (-)	√ (-)	X	√ (-)	√ (+)	√ (+)
Machining- Manual	√ (-)	√ (-)	√ (-)	X	√ (-)	√ (+)	√ (+)

√ (+): positive impacts; √ (-): negative impacts; √ (Θ): positive and negative impacts; X: does not affect

¹⁴⁴ [Supporting document/Non Permanence Risk tool/Internal Risk/Organization chart]

Table 18: Potential negative impacts of project activities and their mitigation measures

Activity	Impacts	Measures
Land Preparation Nurseries Thinning Exploitation	Flora and Fauna	Relocation of fauna species.
Nurseries Thinning Exploitation	Soils	Nurseries: look for areas with similar characteristics and protect them. There is only one location for nursery Thinning: that the activities are mechanized. Exploitation: that the activities are mechanized.
Land preparation Thinning Exploitation	Air	Vehicles and equipment are in optimal conditions and their maintenance is adequate.
Nurseries	Water	Strict use of water by micro-sprinklers for irrigation.
Plantation Pruning Thinning Fertilization Health Fires Exploitation	Health	Training in different areas such as work posture, personal protective equipment, use of chemical substances, fire control, etc.

The project is not expected to generate negative impacts on the environment and the community, as long as the proposed mitigation measures are followed. Support already exists for the non-harmful impacts of the project in the form of the certification for Environmental Compliance, which was granted to the project by the Secretary of Environment and Natural Resources.

Regarding social impacts, a summary of the social impacts of the project is presented in section 1.13 (Sustainable Development). A more detailed description is found as a supporting document¹⁴⁵. The main fear that employees expressed during the local consultation was the use of agrochemicals, for which

¹⁴⁵ [Supporting documents\Non-permanence risk tool\Internal risk\Project management]

protocols¹⁴⁶ are available. In addition, AGSA complies with what is stipulated in the Official Mexican Standard for the use of agrochemicals and the guidelines established by the FSC¹⁴⁷.

5.2 Environmental Impact

Commercial forest plantations with sustainable management reduce the pressure on natural forests, protect soil, capture carbon and generate economic income for rural communities¹⁴⁸. Teak (*Tectona grandis*) is an important exotic species for commercial forest plantations in Mexico. It has adapted well in the states of Campeche, Chiapas, Tabasco, Veracruz, Michoacán and Nayarit¹⁴⁹. Within PRODEPLAN¹⁵⁰, teak is one of the main timber species that has received support for its planting (Figure 34).

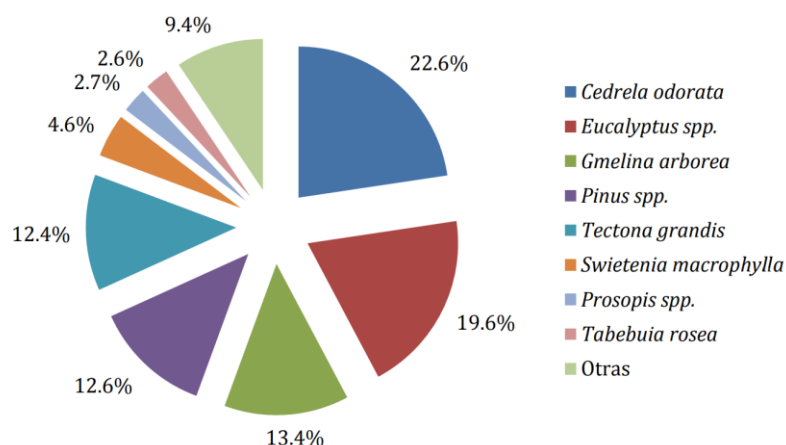


Figure 34: Main species used in established commercial timber plantations¹⁵¹

For the PO, it is important to respect the areas of natural recovery and low areas, among others. Approximately, 2,021 ha of these areas classified as natural areas have been left untouched, which represents 25% of the total area that the company has managed for productive purposes since 2013. The PO has established policies for the protection and care of the environment: it has emphasized mechanisms to learn about the diversity of the flora and fauna on its properties, as well as rules for their protection, especially for those which have conservation classification, listed in NOM-059-SEMARNAT-2010.

In addition to forest plantations, the project is present in areas of recovery and secondary vegetation, with the purpose of conserving biodiversity and generating the following impacts:

¹⁴⁶ More information in: Non-permanence risk tool

¹⁴⁷ Forest Stewardship Council

¹⁴⁸ G. Langenberger and J. Liu, "Performance of Smallholder Teak Plantations (*Tectona grandis*) in Xishuangbanna, south-west China," Journal of Tropical Forest Science, vol. 25. Forest Research Institute Malaysia, pp. 289–298, 2013.

¹⁴⁹ CONAFOR, National Forestry Commission (2013) Program of development of commercial forest plantations. To 15 years of its creation. National Forestry Commission. Zapopan, Jalisco, México. 190 p.

¹⁵⁰ Government program: *Programa de Desarrollo de Plantaciones Forestales Comerciales*

¹⁵¹ SEMARNAT – CONAFOR. Programas Específicos de Intervención Institucional. Programa de Plantaciones Forestales Comerciales 2014-2018. Retrieved from https://www.gob.mx/cms/uploads/attachment/file/251747/Programa_especifico_de_intervencion_institucional_Plantaciones_Forestales_Comerciales_2014-2018.pdf. Supporting document [Supporting documents/ Programa específico de intervención institucional PFC 2014-2018].

Table 19: Possible environmental impacts of the project

Impact	Effect	Actual/ Predict	Direct/ Indirect
Increase in forest cover	Positive	Actual	Direct
Increase in environmental services	Positive	Actual	Direct
Conservation of fauna habitats	Positive	Predicted	Indirect
Increase in biodiversity (fauna and flora)	Positive	Predicted	Indirect
Carbon sequestration	Positive	Predicted	Indirect
Improvement of soil conditions (better infiltration, nutrients movement, organic matter)	Positive	Predicted	Indirect
Increase in food availability for animals	Positive	Predicted	Indirect

5.3 Local Stakeholder Consultation

Methodology

The project area is divided into five municipalities: Balancán (State of Tabasco), Palenque (State of Chiapas), Candelaria (State of Campeche), Huimanguillo (State of Tabasco) and Tenosique (State of Tabasco). Surveys were carried out in farms in these municipalities. The surveys were applied to a group of people present in the farms who interact with the company or who work for the company. Surveys were also conducted with public employees and employees of the private sector.

15 days before the survey was undertaken, information on the carbon project was sent via email to workers. In addition to this, prior to doing the survey (during the presentation), workers were shown several videos to relay information related to the carbon cycle and explain what the voluntary carbon market is.

Two types of surveys were prepared: i) one designed for company workers, which sought basic social information on the respondent, their knowledge of the problem of climate change, the identification of environmental impacts and finally their thoughts regarding working conditions; ii) a survey for public employees and the private sector that differed from the one described above by not asking about labor aspects.

The objective of the surveys was to determine the perception of the forestry community about the role of forest plantations in climate change, under the assumption that the company's workers are inhabitants of the communities closest to the farms where the plantations to be certified are located.

Results:

Surveys were applied in the five municipalities where the plantations to be certified are located (Figure 35). In total, there were 77 surveys distributed: 57 to people who work in AGSA, 6 to people who work for a

contractor that provides specialized services to AGSA, 7 to public officials and 7 to community members not affiliated with the company.



Figure 35: Stakeholder consultation meetings

Below is a summary of the survey results. The detailed report and the evidence of the meetings and surveys can be found as supporting information¹⁵²:

- The overall perception of the workers (69%), together with that of the public officials (100%), and the community (86%), was in favor of the activities of AGSA. The company has an acceptance of around 85%, placing this perception between good and very good.
- Most people consulted consider that the presence of AGSA generates positive impacts for the environment. They noted positive impacts for local flora and fauna, an increase in aquifer levels, improved air quality and better smells in the area.
- On the other hand, the greatest environmental concern is the use of agrochemicals. To resolve the workers' concerns regarding this point, the company will socialize its agrochemical protocol. This involves specifying the doses, the preventive measures to be followed, the appropriate equipment for handling and emphasizing that 100% of the agrochemicals used in the plantation are of low toxicity and are on the list of products allowed by the FSC.
- From a social point of view, the respondents perceive AGSA as a company that generates employment and improves family income and social welfare. 84% of respondents noted improvements in their quality of life and 8% stated that they have improved their diet.

¹⁵² Supporting folder [Local stakeholder consultation \LSC_report]

- Also, 66% of the workers stated that they have received training and 50% considered this training good.
- In terms of the community, people reported that the presence of AGSA and its employment has reduced two social phenomena: emigration and delinquency. The community believed that the main activity in the region if AGSA did not exist would be livestock farming, an activity that emits the GHG methane.

On-going communication with local stakeholders

Employees:

From the Human Resources Directorate of AGSA, the following mechanisms have been generated to address the concerns, suggestions and complaints of workers:

- Direct discussions with the workers: Workers meet, together with representatives from Human Resources, and they analyze issues of work safety, salaries, transportation, schedules, payment questions, etc. This allows workers to be informed and, in certain cases, to solve disagreements.
- IDEAS FACTORY Program: To obtain a better idea about what workers think, every two years the Factory of Ideas program is implemented. Here workers are given the opportunity to express ideas that may improve their work environment, its facilities, its transportation, its activities, etc. This program tries to incentivize the IDEAS or suggestions of the workers. It aims to have the workers be the ones who propose their own changes. It also serves as a mechanism to receive complaints.
- Human Resources: Another viable option is for workers to go directly to the human resources area so that their doubts about faults, permits, vacations, loans, payroll doubts, etc. can be answered.

Community:

Communication between the community and AGSA is directed through the corresponding ranch Manager¹⁵³, who channels it to the Human Resources Department and presents it to AGSA committee to decide the response.

5.4 Public Comments

There were no public comments.

6 ACHIEVED GHG EMISSION REDUCTIONS AND REMOVALS

6.1 Data and Parameters Monitored

Data / Parameter	A
Data unit	Ha
Description	Project Area (planted area).
Source of data	Survey databases of each polygon that is part of the project.

¹⁵³ The organization chart of the company with the structure by ranch and the people in charge is found as a supporting document [Non permanence risk tool\Internal risk\Project management\organization_chart]

Description of measurement methods and procedures applied	The area was delineated on the ground using GPS.
Value applied	3,743.06
Monitoring equipment	GPS equipment
Comments	NA

Data / Parameter	A_i																								
Data unit	Ha																								
Description	Area of stratum i																								
Source of data	GPS coordinates.																								
Description of measurement methods and procedures to be applied	The area was delineated on the ground using GPS.																								
Value applied	<table> <tr> <th>Strata</th><th>Area (ha)</th></tr> <tr><td>I</td><td>908.76</td></tr> <tr><td>II</td><td>130.78</td></tr> <tr><td>III</td><td>109.96</td></tr> <tr><td>IV</td><td>39.51</td></tr> <tr><td>V</td><td>1,168.64</td></tr> <tr><td>VI</td><td>38.02</td></tr> <tr><td>VII</td><td>986.11</td></tr> <tr><td>VIII</td><td>136.38</td></tr> <tr><td>IX</td><td>28.07</td></tr> <tr><td>X</td><td>443.84</td></tr> <tr><td>XI</td><td>174.37</td></tr> </table>	Strata	Area (ha)	I	908.76	II	130.78	III	109.96	IV	39.51	V	1,168.64	VI	38.02	VII	986.11	VIII	136.38	IX	28.07	X	443.84	XI	174.37
Strata	Area (ha)																								
I	908.76																								
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VI	38.02																								
VII	986.11																								
VIII	136.38																								
IX	28.07																								
X	443.84																								
XI	174.37																								
Monitoring equipment	GPS equipment																								
Comments	NA																								

Data / Parameter	N
Data unit	Dimensionless
Description	Number of plots established in the project area.
Source of data	Estimation

Description of measurement methods and procedures to be applied	The number of plots required for measuring the variation within the project boundary and strata was estimated by using the CDM tool "A/R Methodological Tool" for "Calculation of the number of sample plots for measurements within A/R CDM project activities". Before the monitoring report, the error estimation was carried out with the last measurements to estimate if further plots must be established. The sampling error was less than 10%¹⁵⁴. Further plots were not established.
Value applied	202 permanent plot established
Monitoring equipment	NA
Comments	NA

Data / Parameter	n_i																								
Data unit	Dimensionless																								
Description	Number of plots to be established in each stratum.																								
Source of data	Estimation																								
Description of measurement methods and procedures to be applied	This value was estimated using the total number of plots and the area of each stratum.																								
Value applied	<table> <tr> <th>Strata</th><th>Number of plots</th></tr> <tr><td>I</td><td>44</td></tr> <tr><td>II</td><td>10</td></tr> <tr><td>III</td><td>6</td></tr> <tr><td>IV</td><td>4</td></tr> <tr><td>V</td><td>53</td></tr> <tr><td>VI</td><td>2</td></tr> <tr><td>VII</td><td>48</td></tr> <tr><td>VIII</td><td>6</td></tr> <tr><td>IX</td><td>2</td></tr> <tr><td>X</td><td>20</td></tr> <tr><td>XI</td><td>7</td></tr> </table>	Strata	Number of plots	I	44	II	10	III	6	IV	4	V	53	VI	2	VII	48	VIII	6	IX	2	X	20	XI	7
Strata	Number of plots																								
I	44																								
II	10																								
III	6																								
IV	4																								
V	53																								
VI	2																								
VII	48																								
VIII	6																								
IX	2																								
X	20																								
XI	7																								
Monitoring equipment	NA																								
Comments	NA																								

Data / Parameter	Plot Location
------------------	---------------

¹⁵⁴ [Supporting documents/Estimations/SamplingError&Uncertainty]

Data unit	Lat/Long
Description	Localization of each sampling plot.
Source of data	Data field sampling.
Description of measurement methods and procedures to be applied	Measured with GPS.
Value applied	See Supporting documents\SIG\Shape\plots
Monitoring equipment	GPS.
Comments	Sample plot location is registered with a GPS and marked on the project map.

Data / Parameter	DBH
Data unit	Cm
Description	Diameter at Breast Height of the trees.
Source of data	Field measurements in sample plots.
Description of measurement methods and procedures to be applied	Typically measured 1.3 m above-ground. Measure all the trees above some minimum DBH in the permanent sample plots that result from the project activity.
Frequency of monitoring/recording	Each time a verification is conducted.
Value applied	See sheet PlotMeasurements2017 in Supporting documents\Estimations\Ex_post_estimations
Monitoring equipment	Tape measure.
Comments	NA

Data / Parameter	H
Data unit	M
Description	Total height of trees.
Source of data	Field measurements in sample plots.

Description of measurement methods and procedures to be applied	Measure all the tree heights in the permanent sample plots that result in the project activity.
Value applied	See sheet PlotMeasurements2017 in Supporting documents\Estimations\Ex_post_estimations
Monitoring equipment	Clinometer, measuring tape.
Comments	NA

Data / Parameter	T
Data unit	Year
Description	Period elapsed between two successive estimations of carbon stock in trees and shrubs.
Source of data	Verification records.
Description of measurement methods and procedures to be applied	NA
Value applied	t2-t1: 2016-2013
Monitoring equipment	NA
Comments	

6.2 Baseline Emissions

In this project the baseline Net GHG removals by sinks is zero as it is explained in section 3.1.

6.3 Project Emissions

The actual net GHG removals by sinks shall be calculated as follows:

$$\Delta C_{\text{ACTUAL},t} = \Delta C_{P,t} - \text{GHG}_{E,t}$$

Where:

- $\Delta C_{\text{ACTUAL},t}$ = Actual net GHG removals by sinks. in year t; t CO₂-e
- $\Delta C_{P,t}$ = Change in the carbon stocks in project, occurring in the selected carbon pools. in year t; t CO₂-e

$GHG_{E,t}$ = Increase in non-CO2 GHG emissions within the project boundary as a result of the implementation of the A/R CDM project activity, in year t. as estimated in the tool "Estimation of non-CO2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity"; t CO2-e

6.3.1 *Change in the carbon stocks in project, occurring in the selected carbon pools. in year t; t CO2-e.*

Planted area during the verification period (2013-2016)

The eligible planted area per property is presented in Table 20. The location of the planted area is presented in Figure 36 to Figure 41.

Table 20: Planted area 2013-2016

State	Municipality	Property name	Year	Eligible Planted Area (ha)
Campeche	Candelaria (Sitio 7)	FRACCI II PREDIO TRES HERMANOS	2014	26.92
		LA ESCONDIDA	2013	20.35
		LA FRANELA	2013	140.90
		LA FRANELA II	2013	8.17
		SAN CARLOS	2013	37.54
		TRES HERMANOS FRACCION I	2013	19.26
	Carmen (Sitio 7)	EL CHUBASCO	2013	1.75
		FRACCI I PREDIO PASO NUEVO	2013	0.73
		LA ILUSION	2013	42.28
Tabasco	Balancan (Sitio 5)	EL PARAISO	2016	79.58
		LA CAOBA LOTE 90	2016	90.58
		LOTE 85	2016	71.15
		LOTE NUMERO 84 MACULIS	2016	70.13
		MACHICHE LOTE 79	2016	36.38
		PREDIO 78	2014	60.15
		PREDIO 86	2014	64.86
		PREDIO EL REGALO	2016	4.02
		PREDIO RUSTICO A. CASTILLO	2016	39.07
		PREDIO RUSTICO RUPERTO MONTOYA	2016	19.02
		PREDIO RUSTICO SOCRATES SACARIAS	2016	7.04
		RANCHO LA LUZ	2016	1.00
		EL CONQUISTADOR	2016	106.74
	Huimanguillo (Sitio 8)	EL POMELO	2015	66.37

State	Municipality	Property name	Year	Eligible Planted Area (ha)
		LA TRINIDAD	2015	112.58
		LOTE 1	2014	19.90
		LOTE 10	2015	28.31
		LOTE 10 A	2015	31.12
		LOTE 10 GREGORIO M	2014	22.71
		LOTE 11	2014	22.07
		LOTE 11 PINO SUAREZ	2015	85.41
		LOTE 13	2014	42.54
		LOTE 14	2014	42.26
		LOTE 16	2014	26.96
		LOTE 17	2014	29.85
		LOTE 18	2014	32.83
		LOTE 1A	2015	40.98
		LOTE 1A GREGORIO MENDEZ	2014	17.86
		LOTE 1B	2015	51.17
		LOTE 2	2014	42.35
		LOTE 2 MERCEDES GAMAS	2015	71.54
		LOTE 20	2014	31.55
		LOTE 20 PINO SUAREZ	2015	77.70
		LOTE 21	2014	20.52
		LOTE 21 PINO SUAREZ	2015	38.50
		LOTE 21-A	2015	24.87
		LOTE 22	2014	38.73
		LOTE 22-A	2014	36.04
		LOTE 24	2014	38.74
		LOTE 27 Y 28	2014	58.83
		LOTE 3 y 5	2014	39.84
		LOTE 30	2014	39.04
		LOTE 31	2014	41.77
		LOTE 31 PINO SUAREZ	2015	62.12
		LOTE 32	2014	17.74
		LOTE 32 PINO SUAREZ	2015	41.97
		LOTE 32-A	2015	30.98
		LOTE 33	2015	36.01
		LOTE 34	2014	51.74
		LOTE 37	2014	38.44
		LOTE 37 MERCEDEZ GAMA	2014	35.20
		LOTE 38	2014	42.17

State	Municipality	Property name	Year	Eligible Planted Area (ha)
		LOTE 39	2014	44.17
		LOTE 41	2014	23.14
		LOTE 42	2014	22.71
		LOTE 42 PINO SUAREZ	2015	70.15
		LOTE 48	2014	20.33
		LOTE 49	2014	19.71
		LOTE 6	2015	40.97
		LOTE 64	2014	38.02
		LOTE 7	2015	34.13
		LOTE 8	2014	21.79
		LOTE 9	2014	32.61
		LOTE 9 PINO SUAREZ	2015	38.59
		LOTE 9-A	2015	32.68
		PREDIO SANTA MONICA	2015	64.90
		PREDIO SANTA PATRICIA	2015	64.79
		Tenosique (Sitio 9)	EL PENSAMIENTO	2016
	EL SACRIFICIO		2016	9.31
	LOTE 1		2016	0.83
	LOTE 11 Y 15		2016	8.12
	LOTE 15		2016	6.79
	LOTE 17		2016	88.26
	LOTE 2		2016	9.03
	LOTE 20		2016	3.22
	LOTE 44		2016	13.41
	SAN OCTAVIO	2016	26.84	
Chiapas	Palenque (Sitio 6)	DONA CARMINA	2013	292.33
		HIDALGO	2013	131.80
Total				3,743.06

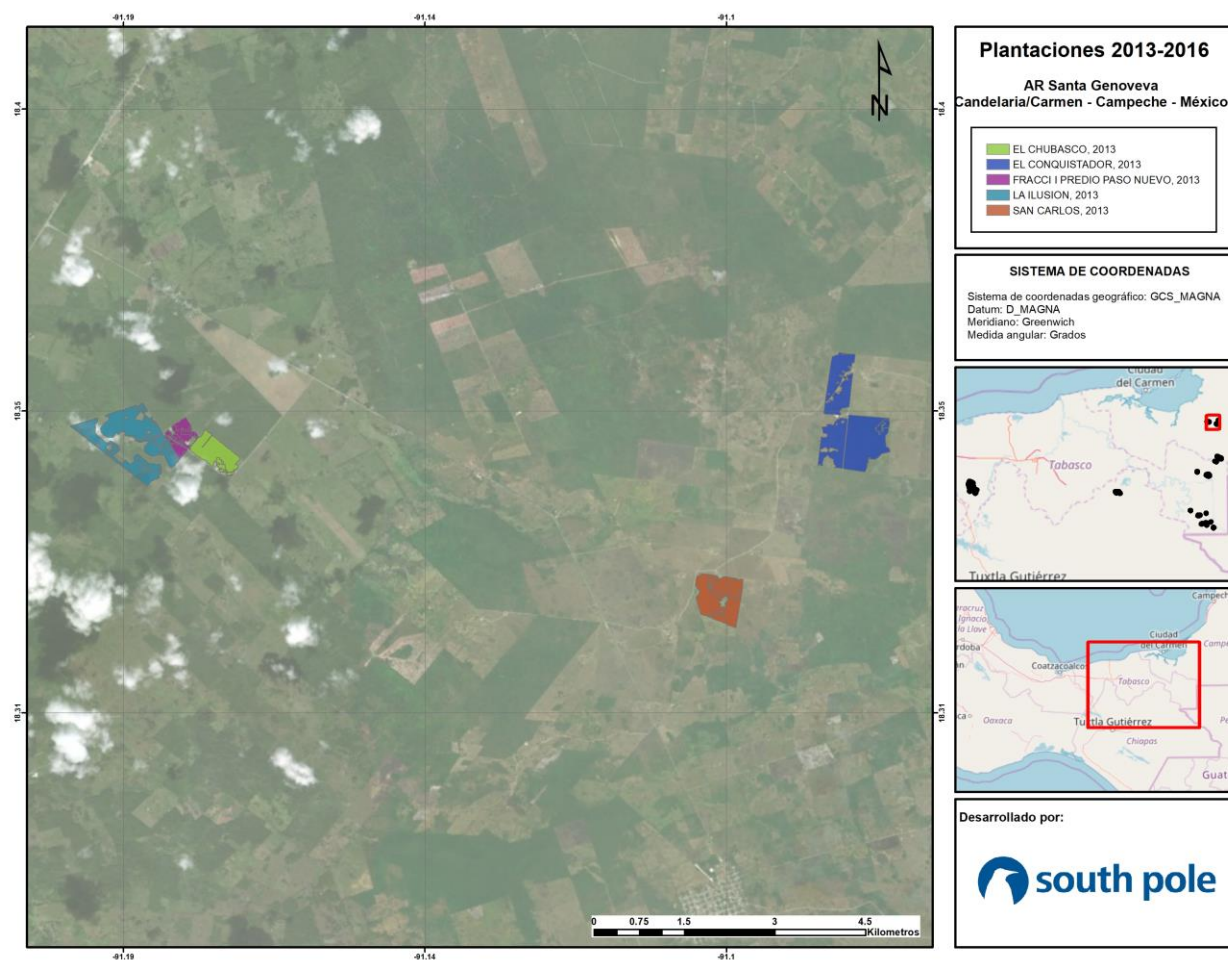


Figure 36: planted area Campeche

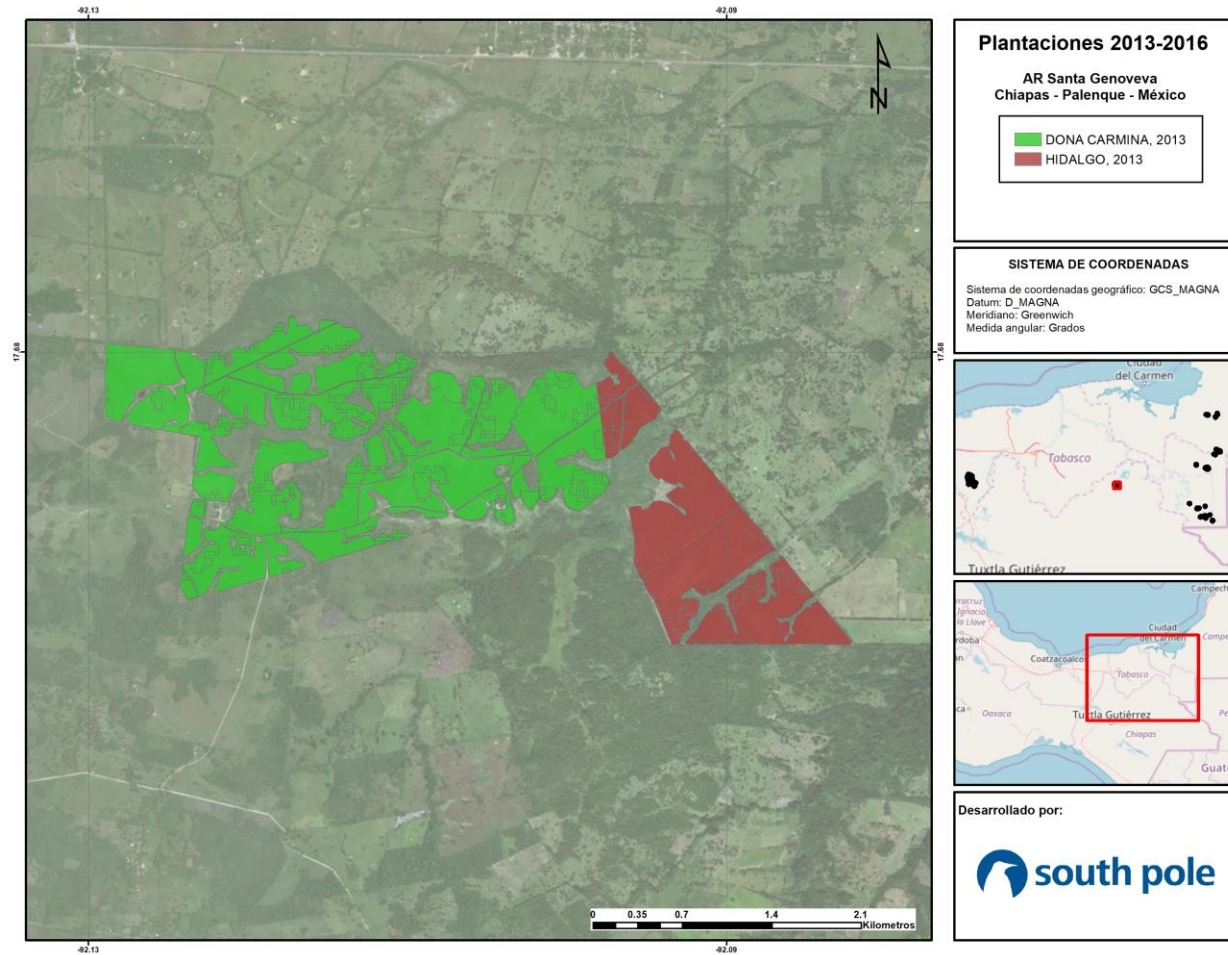


Figure 37: planted area Chiapas

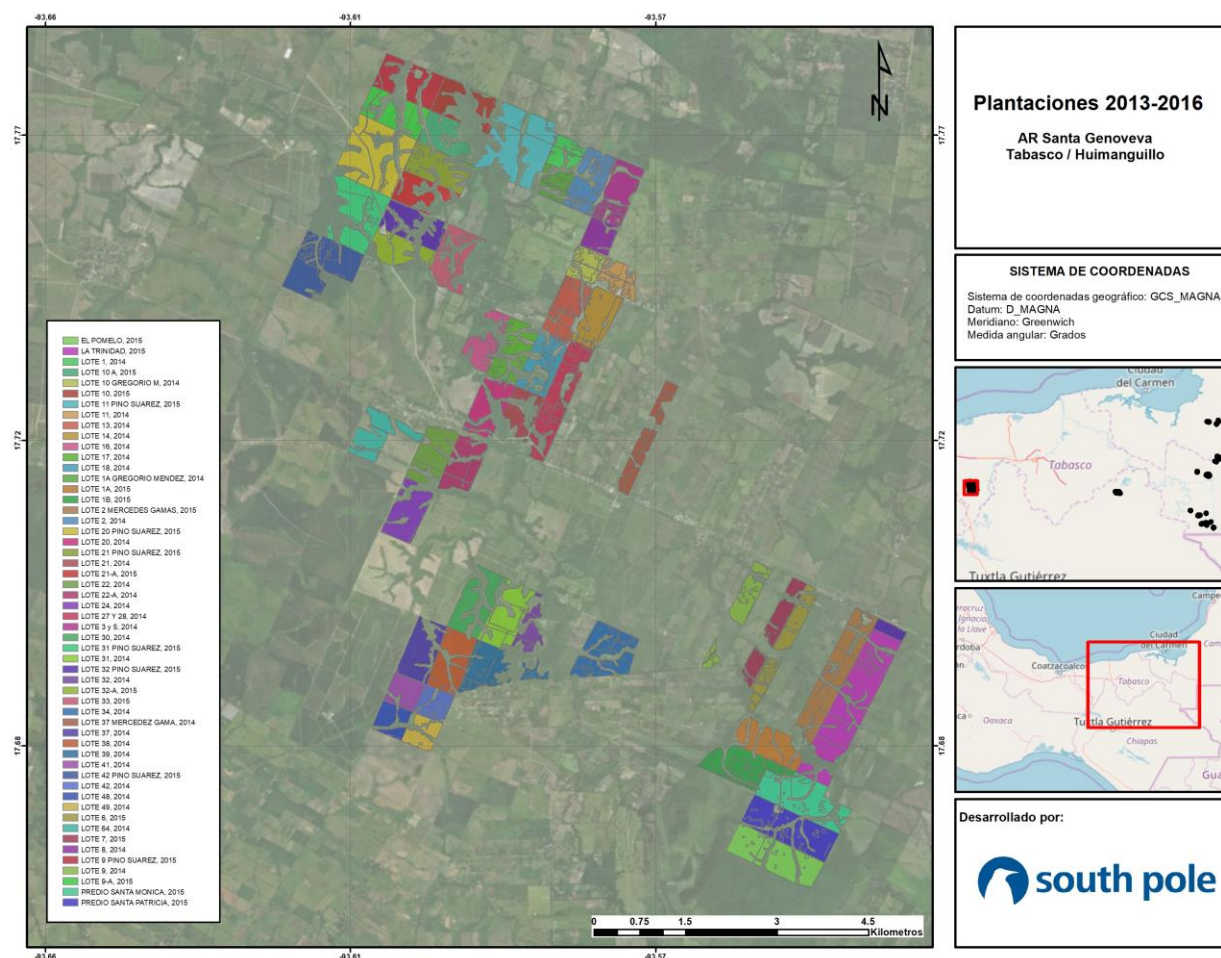


Figure 38: planted area Tabasco (Huimanguillo)

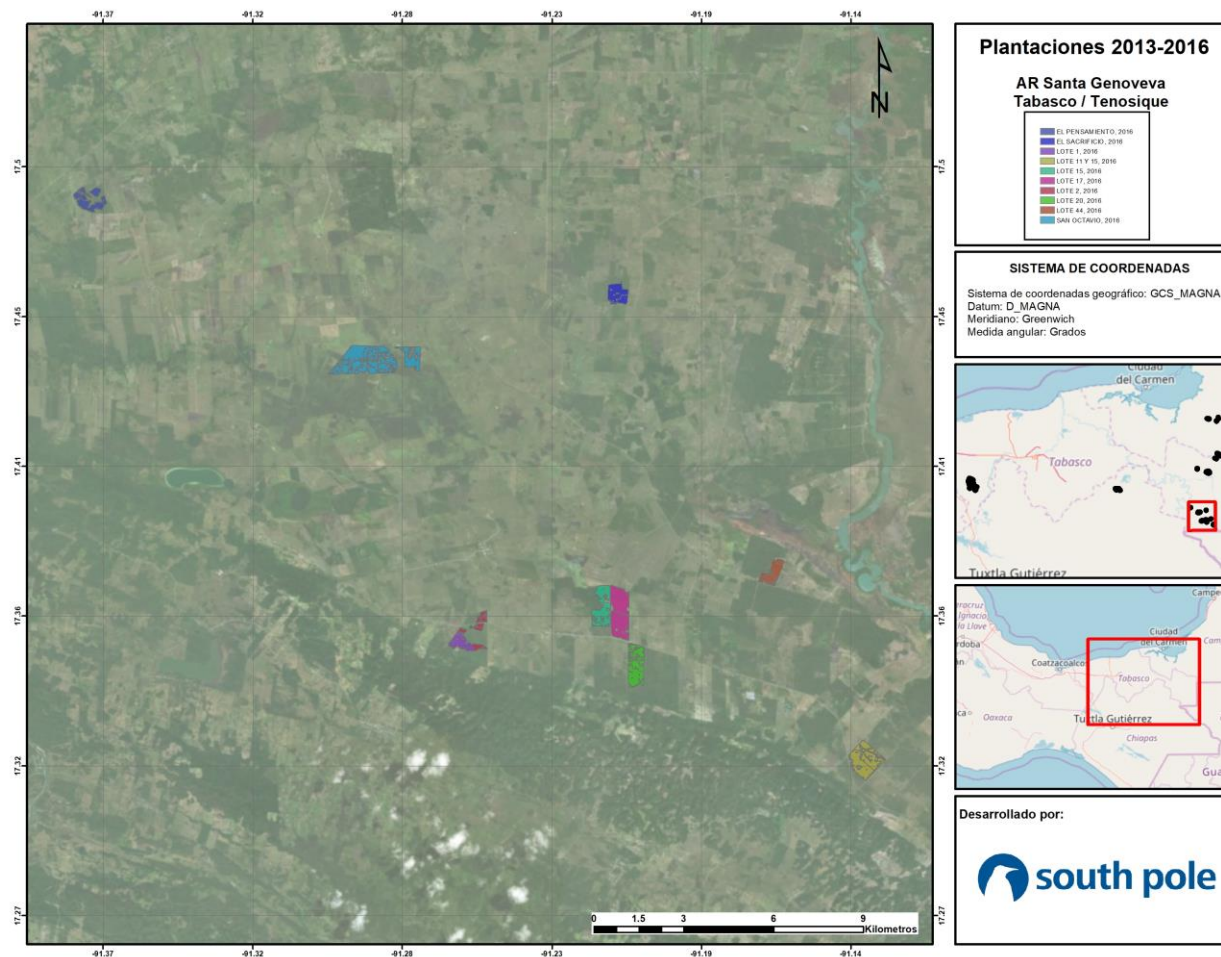


Figure 39: planted area Tabasco (Tenosique)

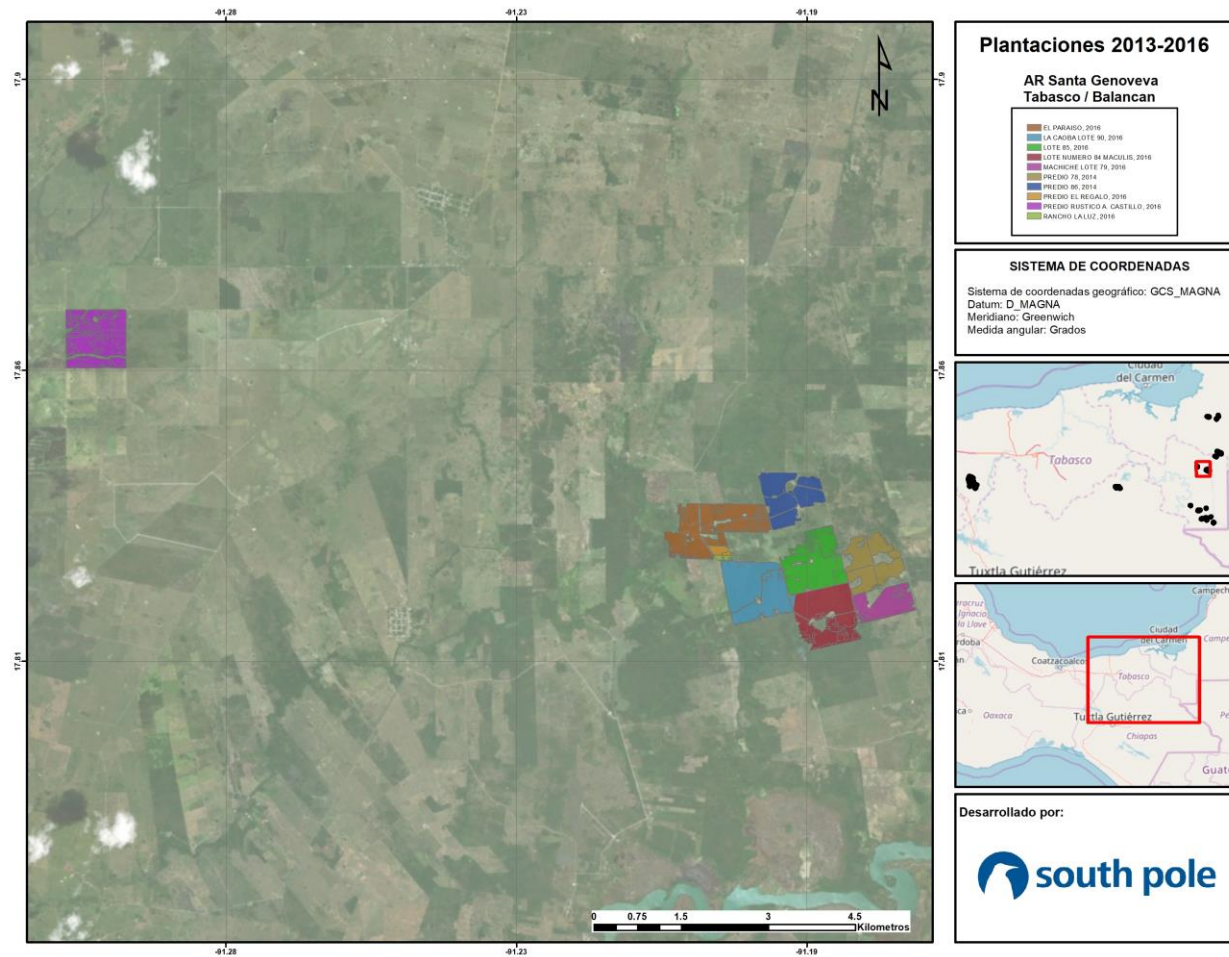


Figure 40: planted area Tabasco (Balancan)

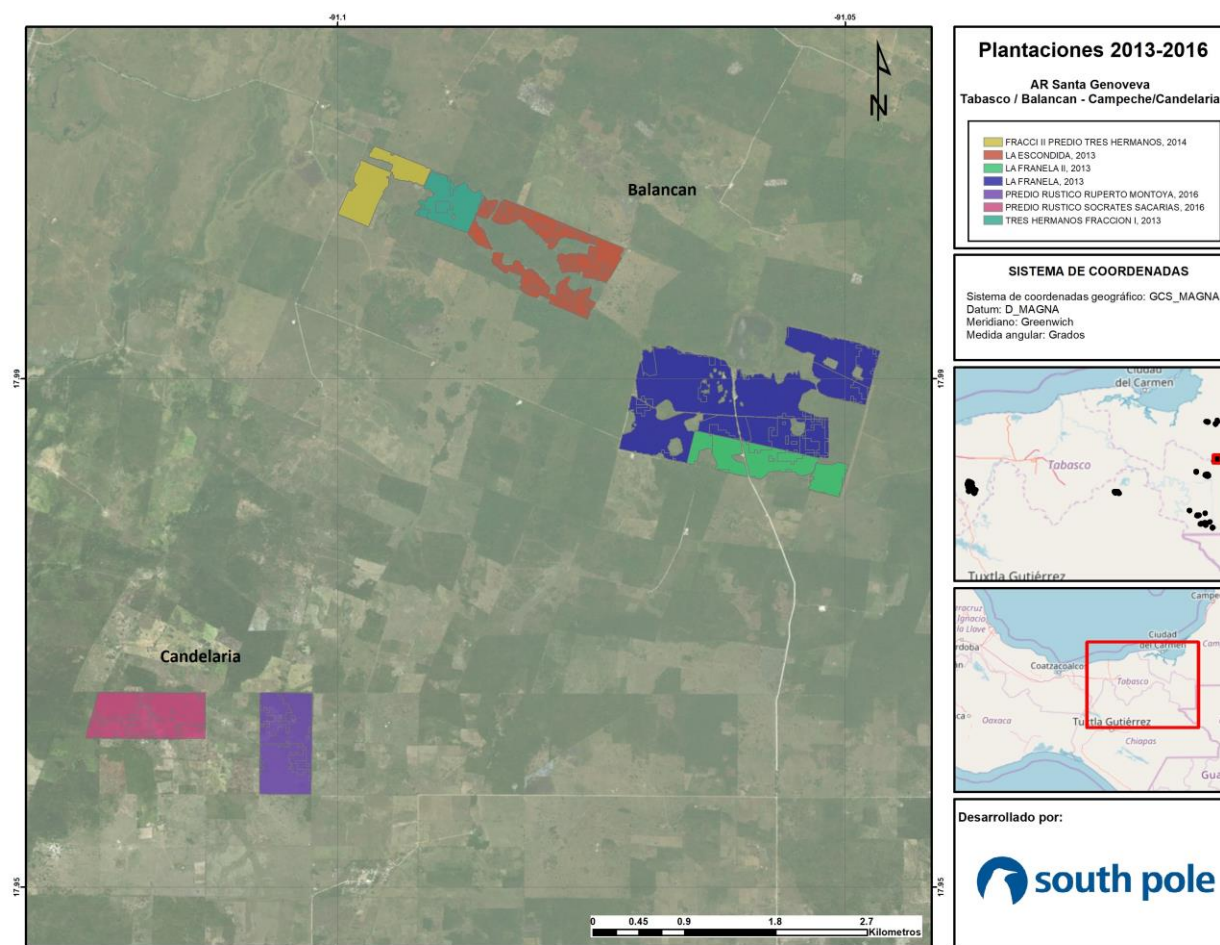


Figure 41: planted area Tabasco (Balancan) – Campeche (Candelaria)

Stratification

According to the “AR-ACM0003 A/R Large-scale Consolidated Methodology: Afforestation and reforestation of lands except wetlands Version 02.0”: *If biomass distribution over the project area is not homogeneous, stratification should be carried out to improve the precision of biomass estimation. Different stratifications may be appropriate for the baseline and project scenarios in order to achieve optimal precision of estimation of net GHG removals by sinks. In particular:*

For actual net GHG removals by sinks the stratification for ex post estimations is based on the actual implementation of the project planting/management plan. In the case of project area monitored for the period 2013-2016, the stratification included the growth quality and the year of establishment (Table 21).

Table 21: Stratification for actual net GHG removals by sinks of the period 2013-2016

Strata	Year of establishment	Area (ha)	Growth quality
I	2013	908.76	Excellent Clon
II	2013	130.78	High
III	2013	109.96	Excellent Seed

Strata	Year of establishment	Area (ha)	Growth quality
IV	2013	39.51	Mean
V	2014	1,168.64	Excellent Clon
VI	2014	38.02	Low
VII	2015	986.11	Excellent Clon
VIII	2015	136.38	High
IX	2015	28.07	Mean
X	2016	443.84	Low
XI	2016	174.37	Mean

Estimating carbon stock in trees at a point in time:

To estimate the carbon stock in tree biomass at a point in time, the following tool was used: *“Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities AR-TOOL14 Version 04.1”*. The method “b) Estimation by measurement of sample plots.

Plot biomass values were estimated from direct measurements conducted on trees in the sampling plots¹⁵⁵. The establishment of the sampling plots was carried out according to section 4.3.2.

- Step 1: Volume estimation¹⁵⁶

Volume estimation depending on diameter and height

The volume estimation per tree depending on diameter and height is found using the Tamarit equation (Tamarit, 2013)¹⁵⁷:

$$V = 0.000059 * DBH^{1.866203} H^{0.932461}$$

V = Tree volume; m³

DBH = Diameter at Breast Height; cm

H = Total height; m

According to the point 1.7 of the Methodological tool *“Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities”*, 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 Version 01.0.1”*¹⁵⁸. The equation used complies with the criteria presented in section

¹⁵⁵ Number of plots established: 202. The location of the sampling plots can be found in [Supporting documents\SIG\Shape\plots].

¹⁵⁶ See Sheet PlotsMeasurement2017 (column AA) in [Supporting documents\Estimations\Ex_post_estimations].

¹⁵⁷ See [Supporting documents\Estimations\REPORT OF VALIDATION_ecuacion volume] and [Supporting documents\Estimations\Tamarit_2013].

¹⁵⁸ <https://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-18-v1.0.1.pdf>

5.C: the equation was derived from a data set of at least 30 sample trees¹⁵⁹, and the value of coefficient of determination (R^2) was not less than 0.85¹⁶⁰.

- *Step 2: Biomass estimation*¹⁶¹

The estimation of tree biomass was calculated according to equation 5 Appendix 1 of the AR-TOOL14:

$$b_{TREE} = [V_{TREE} \times D \times BEF_2] \times (1 + R)$$

b_{TREE}	=	Mean tree biomass per hectare in the tree biomass estimation strata; t d.m. ha ⁻¹
V_{tree}	=	Mean tree volume per hectare in the tree biomass estimation strata; m ³ ha ⁻¹
D	=	Basic wood density; t m ⁻³
BEF_2	=	Biomass Expansion Factor; dimensionless
R	=	Root-to-shoot ratio; dimensionless

- *Step 3: mean carbon stock estimation and mean carbon stock in terms of CO₂e*¹⁶²

The estimation of the mean tree carbon per hectare in the tree biomass estimation strata was calculated according to equation 13 of the AR-TOOL14:

$$B_{tree} = A \times b_{tree}$$

B_{TREE}	=	Tree biomass in the tree biomass estimation strata; t d.m.
A	=	Sum of areas of the tree biomass estimation strata; ha
b_{TREE}	=	Mean tree biomass per hectare in the tree biomass estimation strata; t d.m. ha ⁻¹

$$b_{tree} = \sum_{i=1}^M w_i \times b_{tree,i}$$

b_{TREE}	=	Mean tree biomass per hectare in the tree biomass estimation strata; t d.m. ha ⁻¹
w_i	=	Ratio of the area of stratum i to the sum of areas of tree biomass estimation strata; dimensionless
$b_{tree,i}$	=	Mean tree biomass per hectare in stratum i; t d.m. ha ⁻¹

¹⁵⁹ See page 25, section 2.4 of the supporting document [Supporting documents/Estimations/Tamarit_2013].

¹⁶⁰ See page 31, cuadro 2.4 of the supporting document [Supporting documents/Estimations/Tamarit_2013].

¹⁶¹ See Sheet ΔC in [Supporting documents\Estimations\Ex_post_estimations].

¹⁶² See Sheet ΔC in [Supporting documents\Estimations\Ex_post_estimations].

The estimation of the uncertainty was calculated according to equation 15 of the AR-TOOL14¹⁶³:

$$u_c = \frac{t_{VAL} \times \sqrt{\sum_{i=1}^M w_i^2 \times \frac{S_i^2}{n_i}}}{b_{tree}}$$

u_c	=	Uncertainty
t_{VAL}	=	Two-sided Student's t-value for a confidence level of 90 per cent and degrees of freedom equal to $n - M$, where n is total number of sample plots within the tree biomass estimation strata and M is the total number of tree biomass estimation strata
w_i	=	Ratio of the area of stratum i to the sum of areas of tree biomass estimation strata; dimensionless
S_i^2	=	Variance of tree biomass per hectare across all sample plots in stratum i ; (t d.m. ha ⁻¹)
b_{TREE}	=	Mean tree biomass per hectare in the tree biomass estimation strata; t d.m. ha ⁻¹
n_i	=	Number of sample plots in stratum i .

The estimation of the mean carbon stock in trees within the tree biomass estimation strata was calculated according to equation 12 of the AR-TOOL14:

$$C_{TREE} = \frac{44}{12} \times C_{tree}$$

C_{TREE}	=	Carbon stock in trees in the tree biomass estimation strata; t CO ₂ e
CF_{TREE}	=	Carbon fraction of tree biomass; t C (t d.m.) ⁻¹
B_{TREE}	=	Tree biomass in the tree biomass estimation strata; t d.m.

Table 22. Parameters used for the estimation of tree biomass and mean carbon stock.

¹⁶³ See Sheet Uncertainty in [Supporting documents\Estimations\SamplingError&Uncertainty]. Equation 15 of the AR-TOOL 14 was used to calculate the uncertainty in tree volume. The uncertainty value is 7.48% , which implies a discount of 0% for the GHG removals of the current monitoring period.

Parameter	Symbol	Value	Source
Basic wood density (t m ⁻³)	D	0.59	Rodríguez Anda, Fuentes T., & Silva Guzmán (2012) ¹⁶⁴
Biomass Expansion Factor (dimensionless)	BEF_2	1.50	IPCC (2003) ¹⁶⁵
Root-to-shoot ratio (dimensionless)	R	0.37	IPCC (2006) ¹⁶⁶
Carbon fraction of tree biomass; t C (t d.m.) ⁻¹	CF_{TREE}	0.47	

- *Step 4: dead wood*

A conservative default-factor value of 6% and 1% was applied according to the precipitation range (see section 3.4)¹⁶⁷.

- *Step 5: Litter*

A conservative default-factor value of 1% was applied (see section 3.4)¹⁶⁸.

- *Step 6: carbon stock in trees at a point of time*

Change in the carbon stocks in the selected carbon pools in the year t were calculated according to the AR-ACM0003 methodology¹⁶⁹:

$$\Delta C_{P,t} = \Delta C_{TREE_PROJ,t} + \Delta C_{SHRUB_PROJ,t} + \Delta C_{DW_PROJ,t} + \Delta C_{LI_PROJ,t}$$

- Where:

$\Delta C_{P,t}$ = Change in the carbon stocks in project, occurring in the selected carbon pools. in year t ; t CO₂-e

$\Delta C_{TREE_PROJ,t}$ = Change in carbon stock in tree biomass in project in year t . as estimated in the tool “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities”; t CO₂-e

¹⁶⁴ See supporting folder [Supporting documents\Estimations\Wood density]. The wood density used is the average value found in the AGSA plantations (Rodríguez et al 2012). The value is supported by other findings in teak plantations in Costa Rica (Serrano et al_Pag 104).

¹⁶⁵ IPCC 2003. “Good Practice Guidance for LULUCF”. The BEF value for Tropical Climatic Zone and Broadleaf Forest Type was used. Table 3A.1.10 of Annex 3A.1.

¹⁶⁶ IPCC, 2006. Table 4.3. http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_04_Ch4_Forest_Land.pdf

¹⁶⁷ See Sheet ΔC (column L-M) in [Supporting documents\Estimations\Ex_post_estimations].

¹⁶⁸ See Sheet ΔC (column N) in [Supporting documents\Estimations\Ex_post_estimations].

¹⁶⁹ See Sheet ΔC (O) in [Supporting documents\Estimations\Ex_post_estimations].

$\Delta C_{SHRUB_PROJ,t}$	=	Change in carbon stock in shrub biomass in project in year t . as estimated in the tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"; t CO ₂ -e
$\Delta C_{DW_PROJ,t}$	=	Change in carbon stock in dead wood in project in year t . 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 CO ₂ -e
$\Delta C_{LI_PROJ,t}$	=	Change in carbon stock in litter in project in year t . 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 CO ₂ -e

6.3.2 Increase in non-CO2 GHG emissions within the project boundary as a result of the implementation of the A/R CDM project activity, in year t .

Increase in non-CO2 GHG emissions ($GHG_{E,t}$) within the project boundary as a result of the implementation of the A/R VCS project activity in year t . as estimated in the Annex 31 "Estimation of non-CO2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity version 04.0.0"; t CO₂-e. Considering equation 1 of this tool:

$$GHG_{E,t} = GHG_{SPF,t} + GHG_{FMF,t} + GHG_{FF,t}$$

Where:

$GHG_{E,t}$	=	Emission of non-CO ₂ GHGs resulting from burning of biomass and forest fires within the project boundary in year t ; t CO ₂ -e
$GHG_{SPF,t}$	=	Emission of non-CO ₂ GHGs resulting from use of fire in site preparation in year t ; t CO ₂ -e
$GHG_{FMF,t}$	=	Emission of non-CO ₂ GHGs resulting from use of fire to clear the land of harvest residue prior to replanting of the land or other forest management. in year t ; t CO ₂ -e
$GHG_{FF,t}$	=	Emission of non-CO ₂ GHGs resulting from fire. in year t ; t CO ₂ -e
t	=	1.2.3. ... years counted from the start of the project activity

According to the tool "Estimation of non-CO2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity", the emission of non-CO₂ GHGs resulting from burning of biomass and forest fires within the project boundary in year t is an estimate based in three sources: i) burning of biomass and forest fires within the project boundary; ii) use of fire in site preparation; and iii) use of fire to clear the land of harvest residue prior to replanting of the land or other forest management. Source i) is considered zero as there were not emissions resulting from burning in the project area during the first verification period. Sources ii) and iii) were considered to be zero, as the project activities did not include the use of fires to prepare land. Considering the previous description, non-CO₂ GHG emissions ($GHG_{E,t}$) are considered to be zero.

6.4 Leakage

In this project, the leakage is zero as it was explained in section 3.4.

6.5 Net GHG Emission Reductions and Removals

According to equation 5 of the methodology AR-ACM0003 v2.0, net anthropogenic GHG removals by sinks shall be calculated as follows:

$$\Delta C_{AR-CDM,t} = \Delta C_{ACTUAL,t} - \Delta C_{BSL,t} - LK_t$$

Where:

- $\Delta C_{AR-CDM,t}$ = Net anthropogenic GHG removals by sinks. in year t; t CO₂-e
- $\Delta C_{ACTUAL,t}$ = Actual net GHG removals by sinks. in year t; t CO₂-e
- $\Delta C_{BSL,t}$ = Baseline net GHG removals by sinks. in year t; t CO₂-e
- LK_t = GHG emissions due to leakage. in year t; t CO₂-e

LK_t can be considered as 0 according to section 5.3, 5.4 and 5.5. Then, $\Delta C_{AR-CDM,t} = \Delta C_{ACTUAL,t} - \Delta C_{BSL,t}$

For the activity instances located in Huimanguillo, the carbon stock loss as result of the harvest of citrus plantation (106 tCO₂e) to prepare the land was discounted in the Net GHG Emission Reductions and Removals. Carbon emissions due to thinning was accounted in the $\Delta C_{ACTUAL,t}$

The total GHG benefit calculated as the sum of stock changes along the monitoring period (2013-2016) is 198,325 tCO₂e (see Excel file "Ex_post_estimations")¹⁷⁰.

Year	Estimated baseline emissions or removals (tCO ₂ e)	Estimated project emissions or removals (tCO ₂ e)	Estimated leakage emissions (tCO ₂ e)	Estimated net GHG emission reductions or removals (tCO ₂ e)
2013	-	15,589	-	15,589
2014	-	-	-	-
2015	-	-	-	-
2016	-	66,108	-	66,108
2017	-	116,628	-	116,628
Total	-	198,325	-	198,325

¹⁷⁰ Estimated net GHG emission reductions or removals (tCO₂e) were calculated based on the information collected in the permanent plots. Number of plots established in the period 2013-2016 meet with the requirements of methodology AR-ACM0003 [Supporting documents/Estimations/SamplingError&Uncertainty]

APPENDIX 1: MEASUREMENT STANDING TREES¹⁷¹

Sistema MiraSiv MEDICION DE ARBOLES EN PIE 18/09/2009

AGROPECUARIA SANTA GENOVEVA S.A. P.I. de C.V. Pág. 1 de 2

Código¹ de país MX Código de² proyecto ASG No. serial del³ experimento 00038 Ns. del⁴ tratamiento 003 Código⁵ de lote 02 Ns. de la⁶ repetición 0

Región⁷ 01-003 Nombre del⁸ sitio POLIGONO -1 Código de⁹ tratamiento TECTGR03

Fecha de¹⁰ plantación 15/07/2003 Fecha de¹¹ medición 07-10-2009 Tipo de¹² diámetro B P=a la altura del pecho (DAP)
B=basal del eje
T=basal del tocón

No. del¹³ rotación 00 Especie-¹⁴ Parcela TECTGR Especie¹⁵ Tectona grandis

No. árboles¹⁶ originales 100 No. árboles¹⁷ vivos 35 Espaciamiento¹⁸ original 400 cm X 200 cm X cm

Anotadores²⁵ Jaime, Joaquín, Gildardo Observaciones²⁶ Se midio a 16 m/s

Árbol No.	Eje No.	Diámetro (mm)	Altura total (dm)	Código de forma y defectos del fuste*	Código de sanidad	% T	% C
1	1	18.4	13.92	1		73+9	0
2	1	-99.00	-99.00				
3	1	-99.00	-99.00				
4	1	-99.00	-99.00				
5	1	16.7	13.76			77+9	2.72 8+9
6	1	14.6	12.32			63+9	2.24 5+9
7	1	-99.00	-99.00				
8	1	19.1	12.96			72+9	1.92 3+9
9	1	-99.00	-99.00				
10	1	-99.00	-99.00				
11	1	-99.00	-99.00				
12	1	-99.00	-99.00				
13	1	-99.00	-99.00				
14	1	MURTO FU. PI.					
15	1	-99.00	-99.00				
16	1	-99.00	-99.00				
17	1	-99.00	-99.00				
18	1	-99.00	-99.00				
19	1	17.0	14.24			80+9	2.40 6+9
20	1	16.7	5.92 A			28+9	0
21	1	-99.00	-99.00				
22	1	-99.00	-99.00				
23	1	-99.00	-99.00				
24	1	14.5	12.64			70+9	2.40 6+9
25	1	14.8	11.52			63+9	3.04 10+9
26	1	-99.00	-99.00				
27	1	15.6	A			33+9	2.24 5+9
28	1	-99.00	-99.00				
29	1	-99.00	-99.00				
30	1	-99.00	-99.00				
31	1	-99.00	-99.00				
32	1	-99.00	-99.00				
33	1	-99.00	-99.00				
34	1	14.8	11.84			65+9	2.72 8+9
35	1	12.7	5.12 A			23+9	0
36	1	-99.00	-99.00				
37	1	-99.00	-99.00				
38	1	M					
39	1	-99.00	-99.00				

Códigos para forma y defectos del fuste: 1=cola de zorro, 2=poco sinuoso, 3=muy sinuoso, 4=torcedura basal, 5=bifurcado, 6=inclinado, 7=enfermo, 8=con plagas, 9=copa asimétrica, A=tallo quebrado con recuperación, B=tallo quebrado sin recuperación, C=sin copa, D=replantación, E=spp extraña, F=rebrote, G=para raleo, H=regeneración natural, I=dominante, J=codominante, K=suprimido, L=ejes rectos y sin defectos de forma, +indica raleado en la última medición

- 99 MURTO

APPENDIX 2: VERIFICATION OF CONSECUTIVE MEASUREMENTS



Presentación Preliminar - mira9-medicionconsecutiva.fr - Página 2

Verificación de Medición Consecutiva

Cód. país: MX Proy.: AGROP. SANTA GENOVEVA, S.A. DE (ASG) Lote-Sitio: 10-001

Nombre Lote: Nombre del sitio: COPY

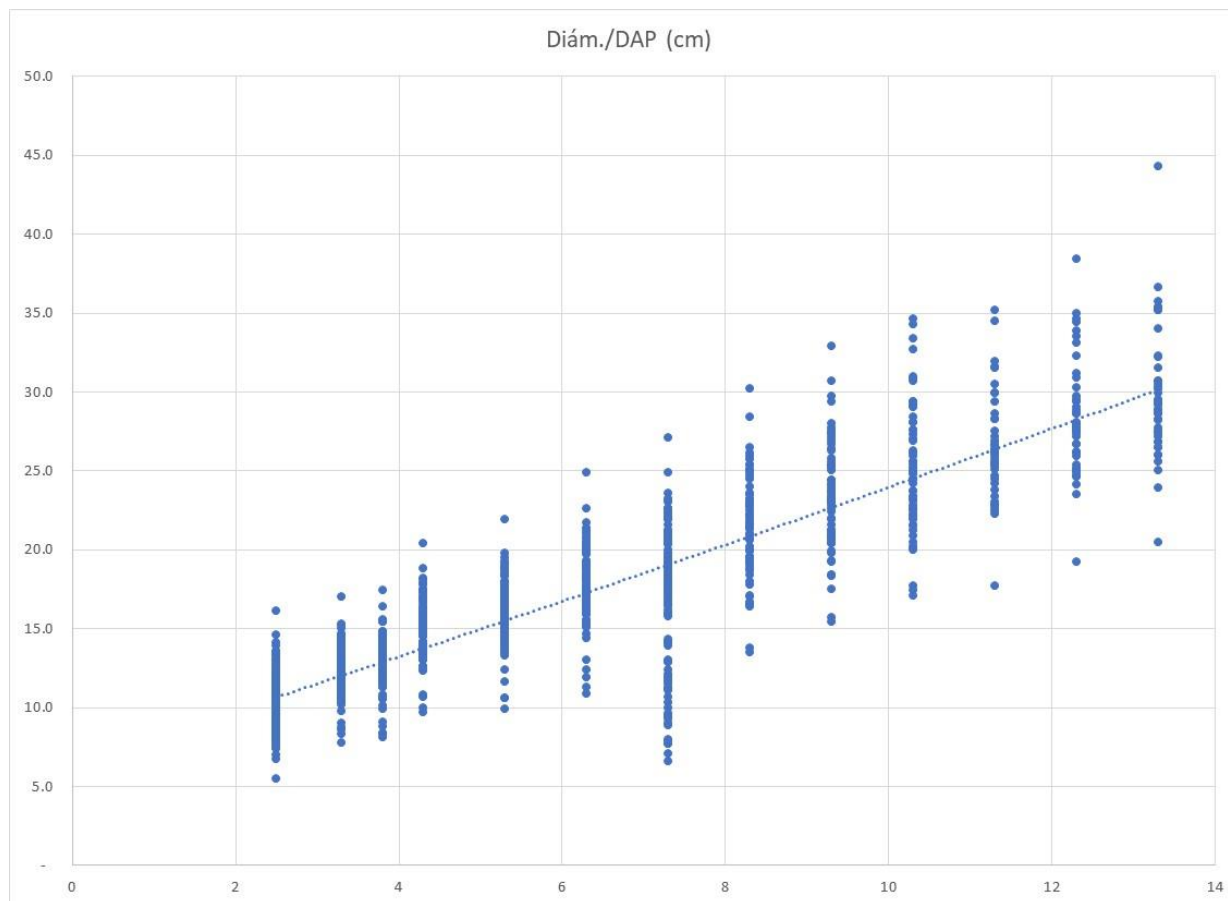
Experimento: 00020 Cód. Tratam.: TECTGR01 Ns. Tratam.: 001 Núm. Repet.: 0

Fecha medición: 15/10/17 Fecha medición anterior: 15/10/16 Δ edad: 12

Especie	Árbol	Eje	Diámetro (cm)				Altura total (m)				Cód. de Forma		Cód. de Sanidad		Raleo
			NS: 15 Edad: 159	NS: 14 Edad: 147	Δ	%	NS: 15 Edad: 159	NS: 14 Edad: 147	Δ	%	NS: 15 Edad: 159	NS: 14 Edad: 147	NS: 15 Edad: 159	NS: 14 Edad: 147	
TECTGR	49	1	-99	-99	--	--	-99	-99	--	--					☐
TECTGR	50	1	-99	-99	--	--	-99	-99	--	--					☐
TECTGR	51	1	29.0	27.6	1.4	5.2	16.3	16.0	0.3	1.6	2	2,1			☐
TECTGR	52	1	-99	-99	--	--	-99	-99	--	--					☐
TECTGR	53	1	-99	-99	--	--	-99	-99	--	--	G	G			☐
TECTGR	54	1	-99	-99	--	--	-99	-99	--	--					☐
TECTGR	55	1	25.1	23.9	1.2	5.1	14.5	14.4	0.1	0.7	2,6	2,1			☐
TECTGR	56	1	-99	-99	--	--	-99	-99	--	--	G	G			☐
TECTGR	57	1	-99	-99	--	--	-99	-99	--	--					☐
TECTGR	58	1	-99	-99	--	--	-99	-99	--	--					☐
TECTGR	59	1	-99	-99	--	--	-99	-99	--	--					☐
TECTGR	60	1	-99	-99	--	--	-99	-99	--	--	G	G			☐
TECTGR	61	1	-99	-99	--	--	-99	-99	--	--	G	G			☐
TECTGR	62	1	-99	-99	--	--	-99	-99	--	--	G	G			☐
TECTGR	63	1	-99	-99	--	--	-99	-99	--	--					☐
TECTGR	64	1	29.2	27.1	2.2	8.0	17.5	17.2	0.3	1.7	2	2,1			☐
TECTGR	65	1	-99	-99	--	--	-99	-99	--	--					☐
TECTGR	66	1	-99	-99	--	--	-99	-99	--	--	G	G			☐
TECTGR	67	1	-99	-99	--	--	-99	-99	--	--					☐
TECTGR	68	1	26.5	24.8	1.8	7.2	18.0	16.8	1.2	7.1	2	1,2			☐
TECTGR	69	1	-99	-99	--	--	-99	-99	--	--					☐
TECTGR	70	1	-99	-99	--	--	-99	-99	--	--	G	G			☐
TECTGR	71	1	-99	-99	--	--	-99	-99	--	--					☐
TECTGR	72	1	25.0	23.2	1.7	7.4	15.5	14.6	0.9	6.2	3				☐
TECTGR	73	1	-99	-99	--	--	-99	-99	--	--					☐
TECTGR	74	1	23.0	21.6	1.4	6.5	15.8	15.6	0.2	1.0	2	1,2			☐
TECTGR	75	1	-99	-99	--	--	-99	-99	--	--					☐
TECTGR	76	1	-99	-99	--	--	-99	-99	--	--					☐

¹⁷¹ The definitions of the fields presented in this form can be found as a support document in [Supporting documents/Plot establishment]

APPENDIX 3: DATABASE FOR THE USUAL IMA IN ACCORDANCE WITH THE QUALITY OF GROWTH FOR DBH



APPENDIX 4: DATABASE FOR THE USUAL IMA IN ACCORDANCE WITH THE QUALITY OF GROWTH FOR HEIGHT