COCOA AND AGROFORESTRY

First conclusions from the Asómbrate program in Colombia

INTRODUCTION

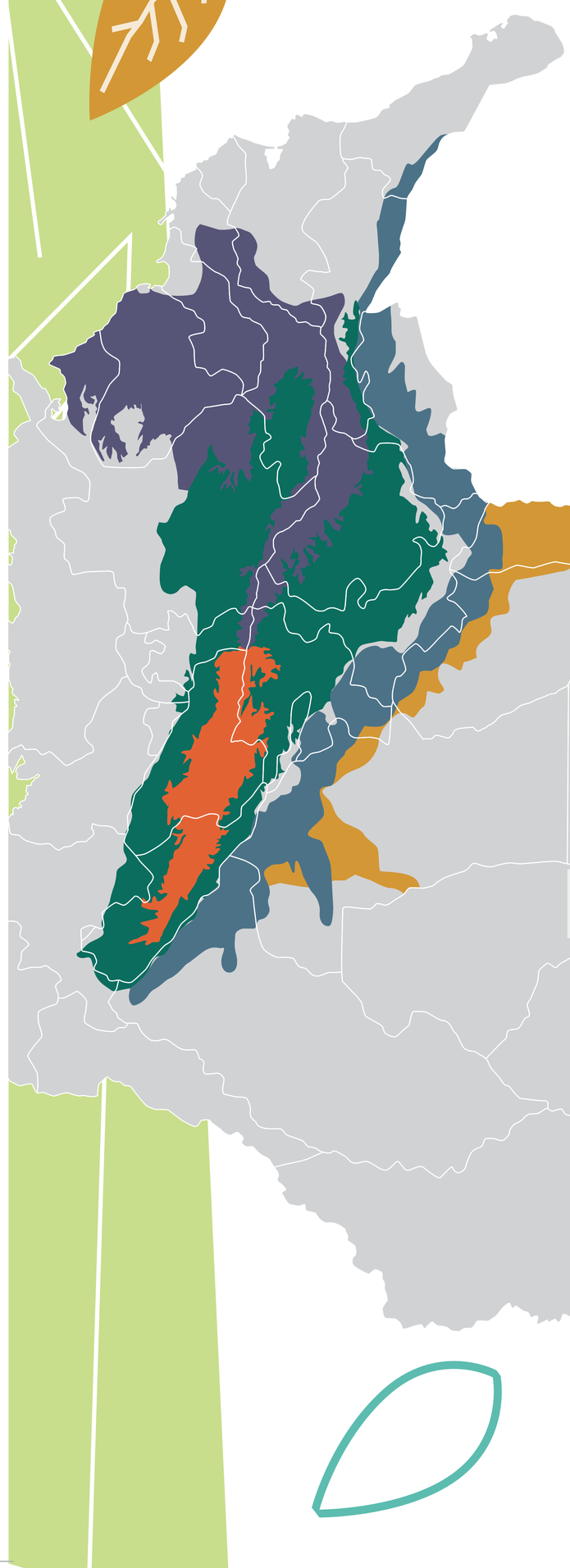
Agroforestry is a land use system where perennial woody species (trees, shrubs, etc.) are associated with herbaceous plants (crops, grasses) and sometimes animals, arranged spatially (Rojas-Gonzáles et al. al., 2019). It aims at taking advantage of the ecological and economic interactions among species in order to obtain environmental and economic benefits (Nair, 1993). To take advantage of the benefits of an agroforestry system (AFS), its composition, structure and operation need to be understood in order to be adapted to productive contexts and climate change scenarios that, for the cocoa value chain, are two key factors for the activity to succeed.

METHODOLOGY

Gentry's (1982) methodology, adapted by Solidaridad-Rabobank, was applied to sample trees more than 1.8 m high and more than 12 cm DBH in 340 cocoa plantations evenly distributed in the following ecoregions: Magdalena valley dry forests, Magdalena-Urabá moist forests and Magdalena Valley Montane Forest. **The importance value** index calculation by species was based on Relative Density, Relative Frequency and Relative Dominance. Additionally, a similar index was calculated for families, including Relative Diversity. The **horizontal and vertical structure** was assessed according to Somarriba's (2013) proposal, using dimetric classes defined by Sturges. The diversity analysis was carried out using the Shannon-Wiener Diversity Index, the Pielou Equity Index and the Simpson Dominance Index.

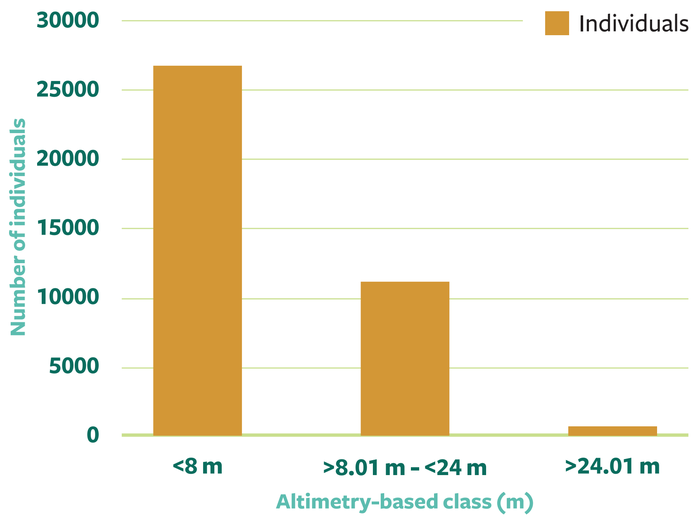
Observed and projected **species accumulation curves** were generated using non-parametric estimators such as Chao-1, Chao-2, Jackknife-1, Jackknife-2 and Bootstrap, with StimateS 9.1.0 software. The **percentage of completeness** was calculated by comparing the number of observed species with the estimated one. The **phenology of the leaves and ecosystem services** were determined through a review of specialized literature. Finally, the **conservation statuses** were established using the International Union for Conservation of Nature-Red List (IUCN, 2022) app.

RESULTS



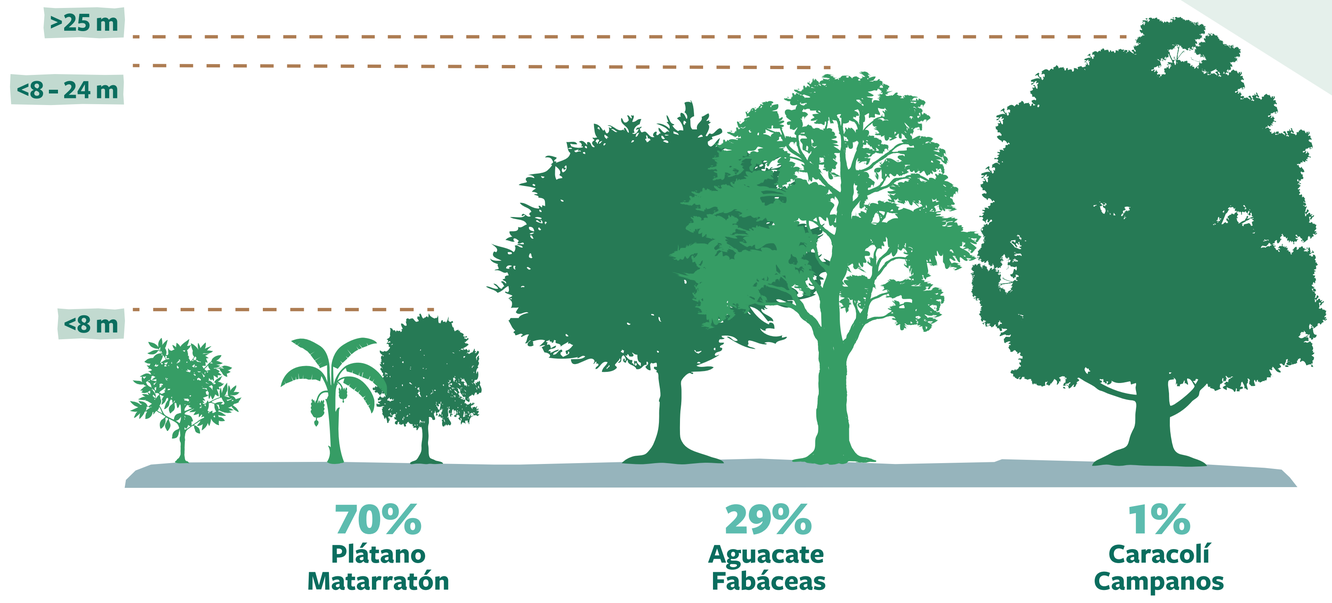
Ecoregion	Magdalena Valley montane forest	Magdalena-Urabá moist forest	Magdalena valley dry forest	Bosque Montano de la Cordillera Oriental	Bosque Seco de Apure-Villavicencio
No. of species	68	101	98	106	104
Abundance	5,118	5,185	7,029	7729	6237
Density (ind./ha)	51	52	70	78	62
No. of families	29	37	32	40	39
Aguacate (*Persea americana*)	33		62.13	21	21
Solera, móncoro (*Cordia alliodora*)	18	18	14.69		
Caracolí (*Anacardium excelsum*)	20				
Cámbulo, cachimbo (*Erythrina poeppigiana*)	13	0	40.3		
Plátano (*Musa x paradisiaca*)		53		37	37
Jobo (*Spondias mombin*)		25			
Iguá, iguamarillo (*Pseudosamanea guachapele*)		18			
Café (*Coffea arabica*)			29.83		
Yopo (*Anadenanthera peregrina*)				15	15
Naranja (*Citrus sinensis*)				16	
Cedro (*Cedrela odorata*)					12

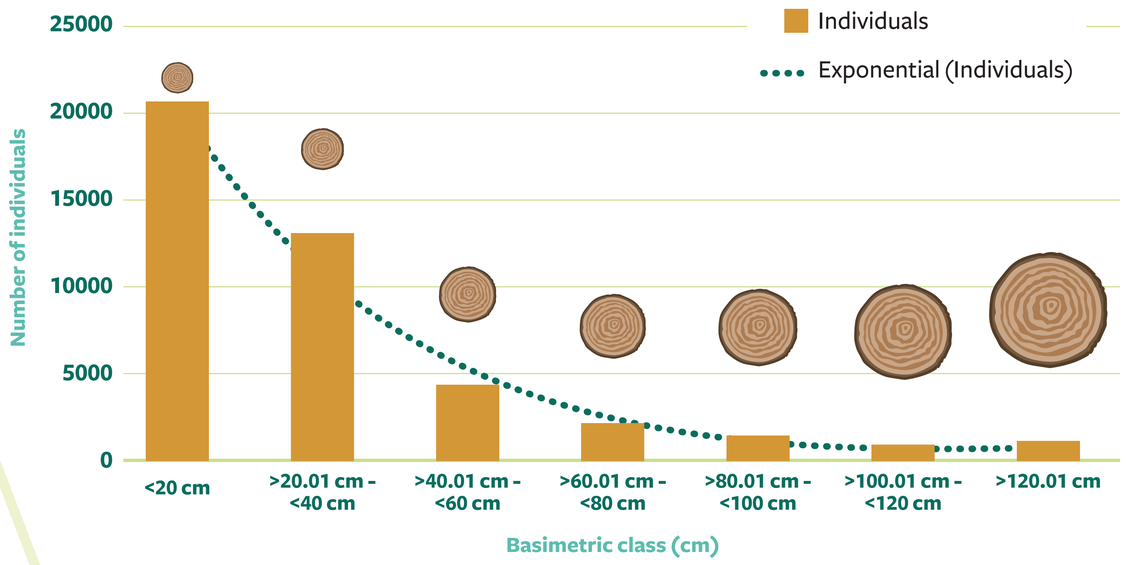
VERTICAL AND HORIZONTAL STRUCTURE



Altimetría. National - 5 ecoregions

<8м: 70%. 8–24 м: 29%. >24,01м: 1%





Café	Aguacate	Cítricos	Nogal, Roble, Abarco, Cedro
$\bar{x}$: 9 cm	$\bar{x}$: 18.2 cm	$\bar{x}$: 19.2 cm	$\bar{x}$: 15 cm

The study finds that the strata by ecoregions in Colombia show similarities, and that the predominant canopy corresponds to Agroforests, with 88% of dispersed trees.

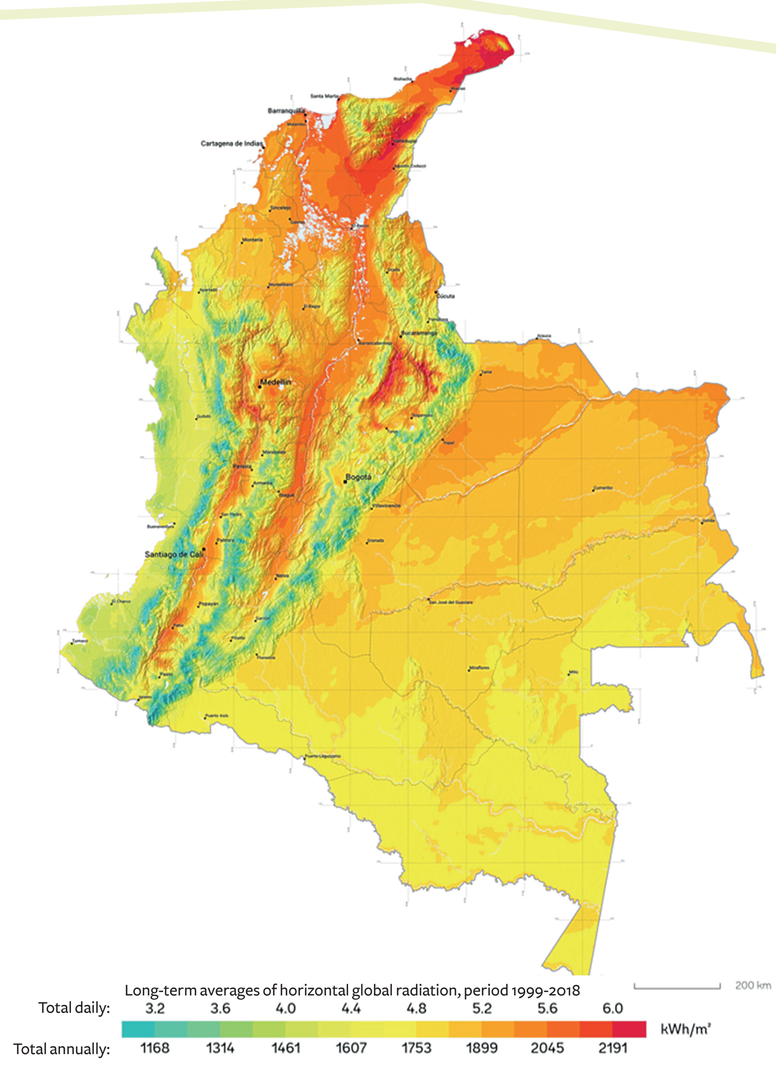
Furthermore, it suggests that new plantings or natural regeneration are occurring, driven by the rapid turnover and replacement of larger trees (Lamprecht, 1990).

ECOSYSTEM SERVICES AND LEAF PHENOLOGY

- **Food for Wildlife** 71%
- **Wood** 21%
- **Wildlife Habitat** 68%
- **Building material** 20%
- **Commercial fruit** 38%
- **Living fences** 17%
- **Medicinal** 30%
- **Pollination** 17%
- **Ornamental** 31%
- **Craft making** 11%
- **Used as AFS** 29%
- **Forage** 10%

- Perennial
  71% Species
  22644 individuals
- Semi-perennial
  8% Species
  7107 individuals
- Deciduous
  23% Species
  6470 individuals

In Colombia, variability in solar radiation can overload plants. An agroforestry strategy that considers canopy levels and leaf cycles is suggested to mitigate this problem. Excess radiation can close plant stomata, impacting their yield and biomass production. (Köhler et al., 2014; Ordoñez- Espinosa, 2019).



RECOMMENDATIONS:

1. In order to choose the species that will make up the cocoa AFS, a participatory process is recommended, taking into account the adaptation of the specimen in the locality, the knowledge about propagation and maintenance of the species, the interest of the owner for its services and the relationship between the tree species and cocoa cultivation.
2. Tree species in cocoa AFS are highly diverse, and environmental conditions impact their adaptation to crop, so transferring a single package of species requires comprehensive evaluations to minimize the risks of errors.
3. To evaluate the supply of solar radiation when establishing cocoa AFS, considering that these vary by region.

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