Soil restoration on rubber and cocoa plantations in Côte d'Ivoire

Abenan N'Guettia Léontine Adahé [1], Joêl-Emmanuel N'Gouan Abrou [1], Kouadio Julien N'Dri [2], Ebagnerin Jérôme Tondoh [2,3], Yves Constant Adou Yao [1,4]

[1] Research team BioValSE, Department of Biosciences, University Félix Houphouët-Boigny, Abidjan, Côte d'Ivoire.
[2] Department of Natural Sciences, University Nangui Abrogoua, Abidjan, Côte d'Ivoire.
[3] Ecology Research Centre, Abidjan, Côte d'Ivoire.
[4] Swiss Centre for Scientific Research in Côte d'Ivoire (CSRS).

September 11 - 13, 2024
(BOKU), Austria
Tropentag 2024

Introduction

- Reduce of soil quality in humid and sub-humid areas in Côte d'Ivoire due to extensive farming.
- Several initiatives to restore soil quality, based on the practice of agroforestry, especially in cacao farms are used.
- However, rubber cultivation is considered a preferred option, as it is well suited to degraded land.
- Assess the contribution of cocoa and rubber plantations in soil quality restoration in Tiéviessou and Goulikao villages.
- Determine specific richness of trees associated to plantations, physico-chemical parameters of soils and assess the impact of trees on soil quality.

Results

- Five associated tree species recorded in rubber plantations compared to 38 tree species in cocoa plantations (Figures 3 and 4).
- 4 species with special-status for conservation hosted in cocoa plantations while rubber plantations shelter none.
- Moreover, 36 to 56.8 stems.ha^{-1} recorded in cocoa plantations, with 7.04 $m^2.ha^{-1}$ basal area then rubber plantations home 5 stems.ha^{-1} equivalent to 0.79 $m^2.ha^{-1}$ basal area.

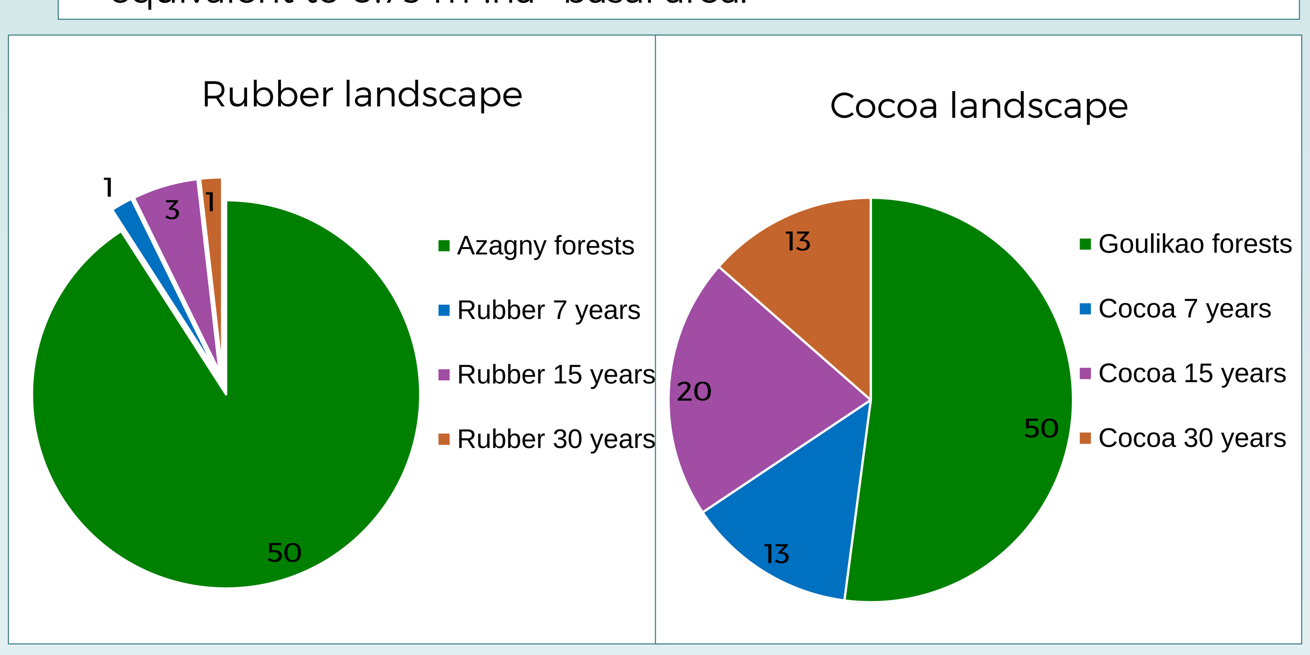

Figure 3 : Tree species richness in rubber and cocoa landscapes.

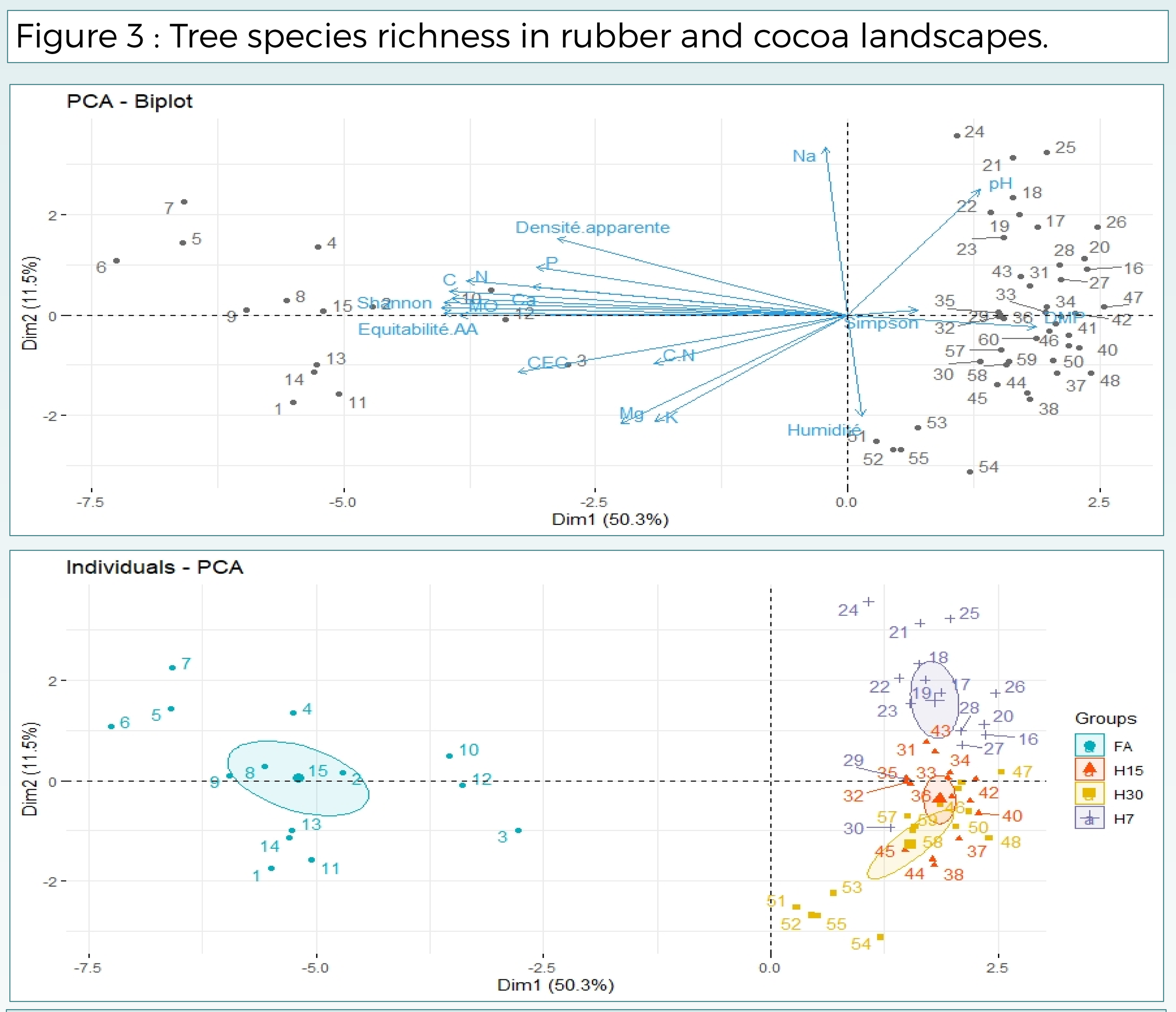

Figure 7 : Principal Component Analysis of floristic and soil physico-chemical parameters in the rubber landscape.

Figure 1: Overview of (a) tree circumference measurement and (b) soil sampling session on a cocoa plantation.

Figure 2: Overview of (a) oven-drying of soil cores and (b) refusals of a composite soil sample after sieving with a 2 mm mesh sieve.

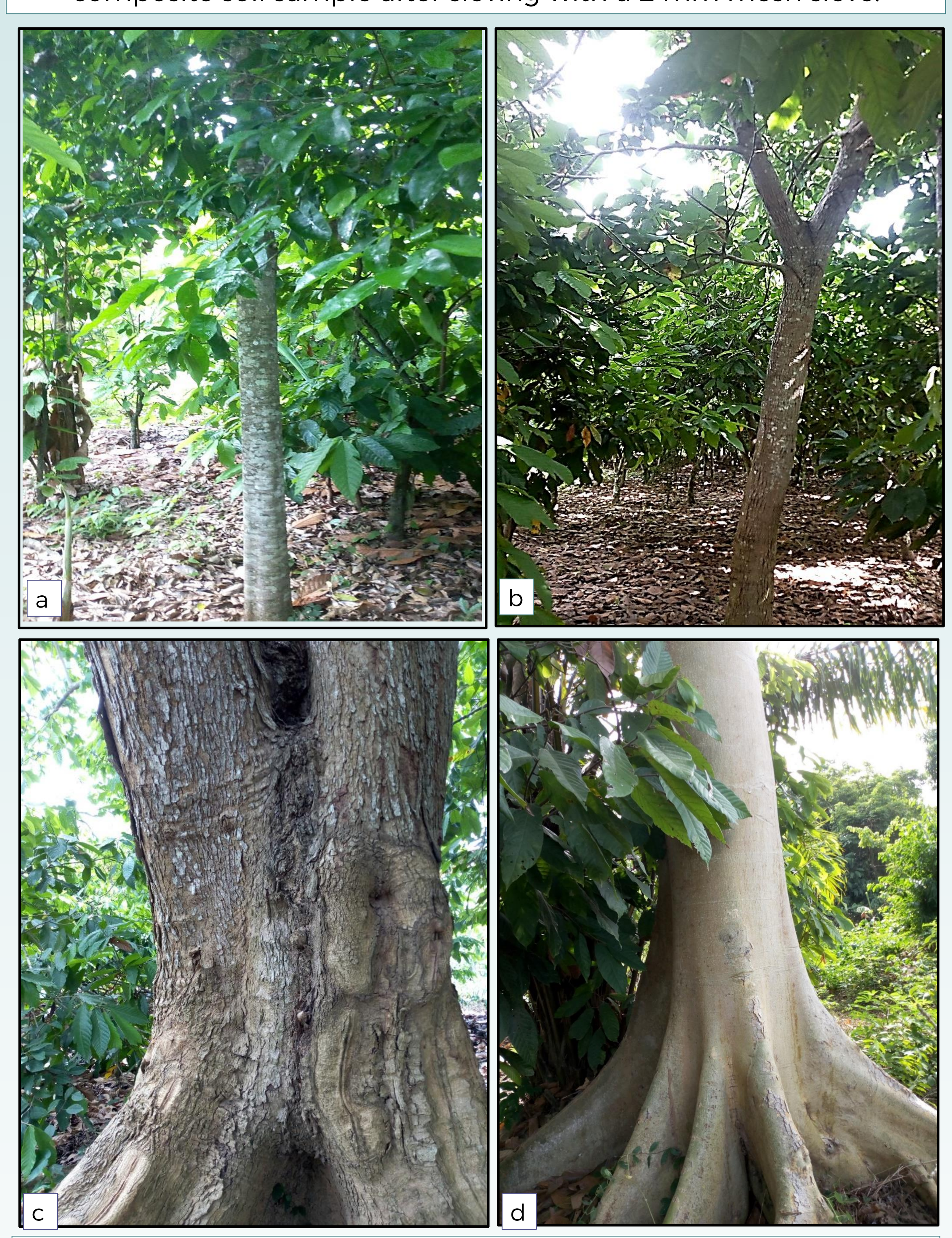

Figure 4 : (a) *Irvingia gabonensis* (b) *Persea americana* (c) *Ricinodendron heudelotii* and (d) *Sterculia tragacantha* in cocoa plantations.

Methods

- Inventory of trees associated with crops in 400 m^2 plots from 24 rubber plantations, cocoa trees aged 7, 15 and 30 years and forests.
- Tree circumferences measurement at breast height (Figure 1.a) and tree richness specific, density and basal area were calculated.
- Soil sampling at 20 cm soil depth using an auger (Figure 1.b).
- Determination of soil bulk density, aggregates Mean Weight Diameter (MWD) and chemical parameters (Figure 2).
- Mean values are compared using parametric (Anova) and non-parametric (Kruskal-Wallis) statistical tests.
- A Principal Component Analysis (PCA) was carried out between floristic and soil physico-chemical parameters.

Results

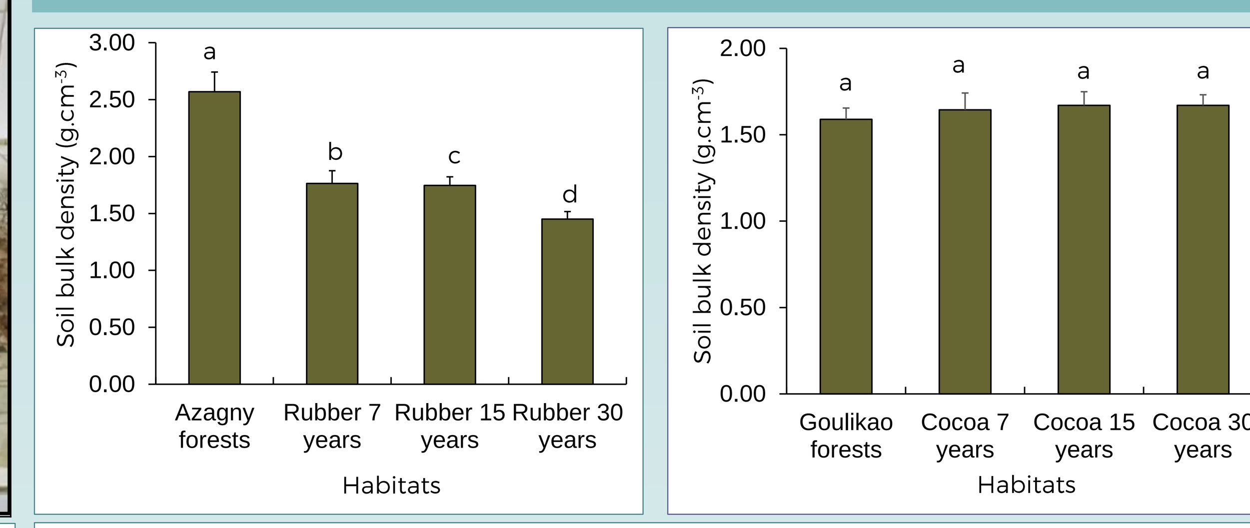

Figure 5: Soil bulk density in rubber and cocoa landscapes.

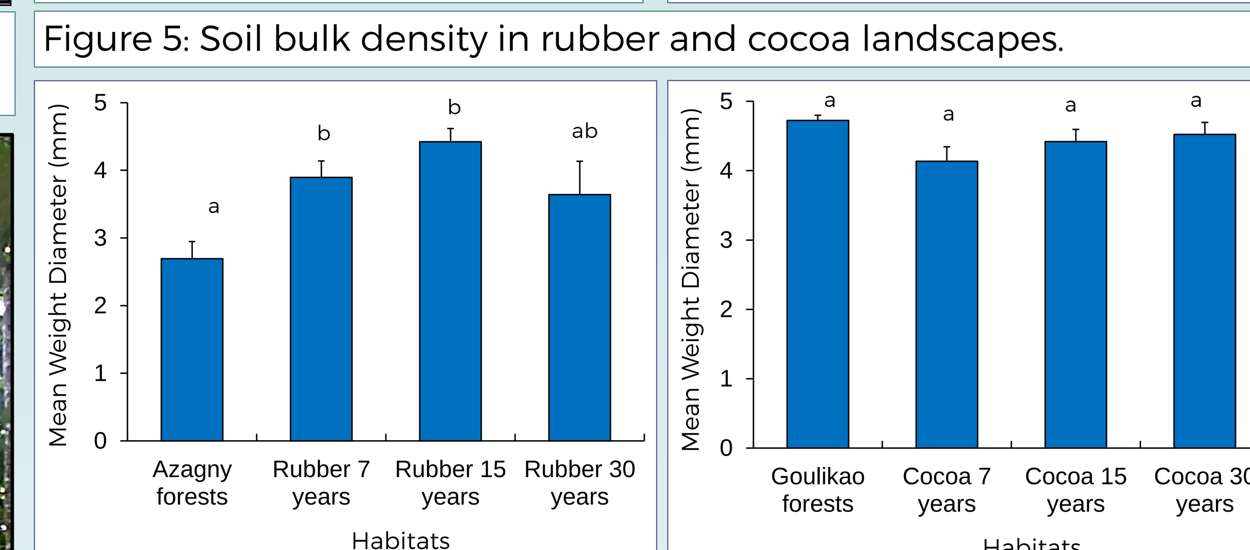

Figure 6: Mean weight diameter of soil aggregates in rubber and cocoa landscapes.

- Soil pH decrease along rubber and cocoa cultivation cycle.
- Carbon contents increase in cocoa plantations hosted the highest diversity of associated trees.

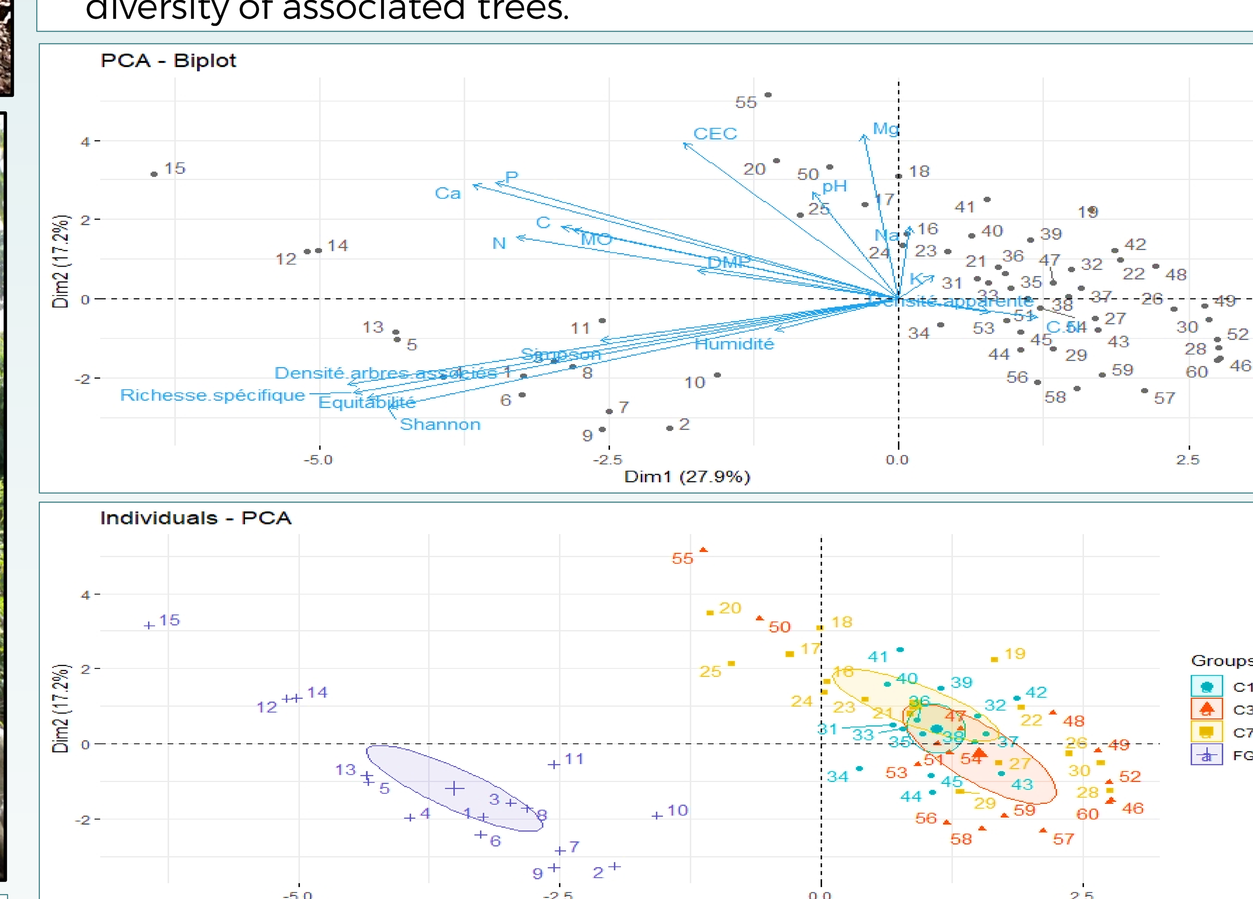

Figure 8 : Principal Component Analysis of floristic and soil physico-chemical parameters in the cocoa landscape.

Highlight

- Tree density higher in cocoa plantations than in rubber plantations.
- Conservation of the physical quality of soils under cocoa trees, with no variation in soil bulk density and in mean weight diameter of soil aggregates.
- Carbon and nitrogen contents of cocoa plantation soils increase with the growth of the basal area of associated trees, evident in 15-year-old cocoa plantations (Figure 8).
- Rubber as a mesophanerophyte species improve soil quality in rubber plantations.
- Adopting agroforestry in all cropping systems would be beneficial for the restoration of the natural soil resource.

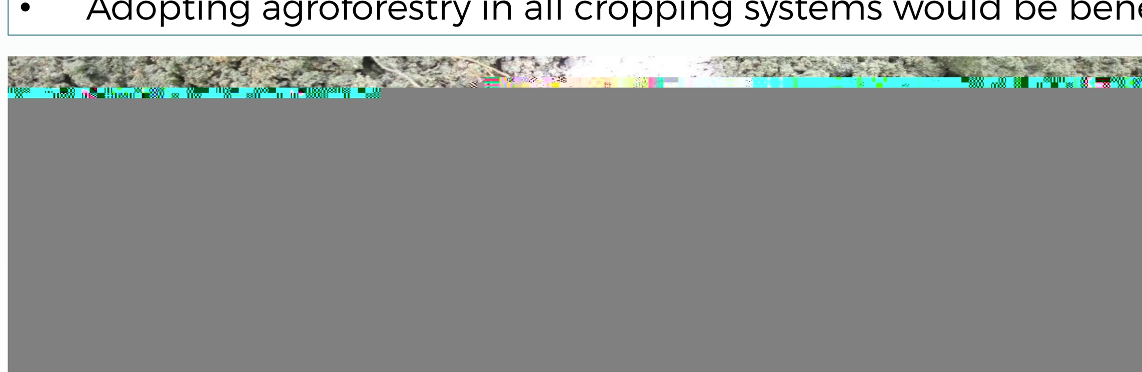

Figure 8 : Improved soil structure in cocoa plantations marked by the presence of native earthworm species *Milsonia omodeoi*.

Acknowledgements

We would like to thank the World Bank for funding this study, through the African Center of Excellence on Climate Change, Biodiversity and Sustainable Agriculture (CEA-CCBAD). To the UFHB university for hosting this work on its premises and BioValSE research team. We would also like to express our gratitude to Nangui Abrogoua University, which made this work possible through a co-direction. Special thanks to the people of the villages of Tieviessou and Goulikao for their frank cooperation in carrying out this work.

Figure 9 : *Irvingia gabonensis* tree in cocoa plantation.