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Logging residues promote rapid restoration of soil health after clear-cutting of rubber plantations at two sites with contrasting soils in Africa

Thibaut Perron^{1,2,3}, Aymard Kouakou^{4,5}, Charlotte Simon⁴, Louis Mareschal^{3,4}, Frédéric Gay^{1,2}, Mouman Soumahoro⁶, Daouda Kouassi⁷, Nancy Rakotondrazafy⁴, Bruno Rapidel^{1,2}, Jean-Paul Laclau^{3,4}, and Alain Brauman⁴

¹CIRAD, ABSys, F-34398 Montpellier, France (thibaut.perron@cirad.fr)

²ABSys, Univ Montpellier, CIHEAM-IAMM, CIRAD, INRAE, Institut Agro, Montpellier, France

³CIRAD, UMR Eco&Sols, F-34398 Montpellier, France

⁴Eco&Sols, Univ. Montpellier, CIRAD, INRAE, Institut Agro, IRD, Montpellier, France

⁵Nangui Abrogoua University, Ecology and Sustainable Development Laboratory, Abidjan, Côte d'Ivoire

⁶SAPH, Direction of Industrial Plantations (DPI), Côte d'Ivoire

⁷SOGB, Agricultural Technique, Auditing and Organisation Department (DTAO), SOCFIN, Côte d'Ivoire

Soil health is defined as the soil's capacity to deliver ecosystem functions within environmental constraints. On tree plantations, clear-cutting and land preparation between two crop cycles cause severe physical disturbances to the soil and seriously deplete soil organic carbon and biodiversity. Rubber, one of the main tropical perennial crops worldwide, has a plantation life cycle of 25 to 40 years, with successive replanting cycles on the same plot. The aim of this study was to assess the effects of clear-cutting disturbance on three soil functions (carbon transformation, nutrient cycling and structure maintenance) and their restoration after the planting of the new rubber crop, in two contrasting soil situations (Arenosol and Ferralsol) in Côte d'Ivoire. In this 18-month diachronic study, we intensively measured soil functions under different scenarios as regards the management of logging residues and the use or not of a legume cover crop. We investigated the relationship between soil macrofauna diversity and soil health. At both sites, clear-cutting and land preparation disturbed carbon transformation and nutrient cycling significantly and, to a lesser extent, structure maintenance function. When logging residues were applied, carbon transformation and structure maintenance functions were fully restored within 12 to 18 months after disturbance. By contrast, no restoration of nutrient cycling was observed over the study period. A legume cover crop mainly improved the restoration of carbon transformation. We found a strong relationship ($P \leq 0.001$; $R^2 = 0.62-0.66$) between soil macrofauna diversity and soil health. Our overall results were very similar at the two sites, despite their contrasting soil conditions. Keeping logging residues in the plots and sowing a legume in the inter-row at replanting accelerated the restoration of soil functions after major disturbance caused by clear-cutting and land preparation. Our results confirm the necessity of taking soil macrofauna diversity into account in the management of tropical perennial crops.

