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Contribution of Internal Nutrient Cycling in a Successional Agroforestry in Tomé-Açu, Pará, Brazil

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Abstract

The Agroforestry System of Tomé-Açu, Brazil (SAFTA) mimics natural succession with commercial species and enables farmers to use their fields for a long period. However, the mechanism of SAFTA, especially on the effects of crop-plant succession on the nutrient and carbon (C) flows, has not yet been well documented. Thus, the objective of this study was to reveal the change and its mechanism in C flow during succession, and clarify the ecological advantages and conditions of SAFTA.

Three different successional stages of SAFTA were selected of the fields planted in 2008 (6 years old; 6YO), in 2002 (12YO) and in 1980 (34YO). The C flow was analysed by measuring the C contents in aboveground biomass, soil, litter and harvest (fruit plus residue), and the carbon dioxide (CO₂) emission from soil. For reference, the C contents in soil and litter and soil respiration were monitored in a nearby secondary forest. The measurements were conducted from September 2012 through July 2014.

The yield of cacao fruit was highest in 12YO and contained 3.3 kg-C tree⁻¹, followed by 34YO and 6YO with 1.9 and 1.5 kg-C tree⁻¹, respectively. Litter was highest in secondary forest with 8.2 Mg C ha⁻¹ year⁻¹. The litter of 6YO, 12YO and 34YO increased with the age, and were 4.6, 5.6 and 7.1 Mg C ha⁻¹ year⁻¹, respectively. Soil respiration rate in the chamber with litter in secondary forest was 176 mg CO₂-C m⁻² h⁻¹, those for 6YO, 12YO and 34YO were 77, 104 and 113 mg CO₂-C m⁻² h⁻¹, respectively. The C balance in 6YO, 12YO, 34YO were 4.1, 4.5, 3.9 ton C ha⁻¹ year⁻¹, respectively.

Our results demonstrated that the amount of litter fall and soil C increased as the SAFTA stages progressed, indicating a higher internal nutrient cycling according to the agroforestry age.

Keywords: Agroforestry, carbon balance, internal nutrient cycle