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Nutrient Cycling and Carbon Stock in an Agroforestry System under Cerrado Climatic Conditions

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ABSTRACT
Nutrient cycling and carbon stock in litter are important processes for maintaining the functionality of agroforestry systems, especially under the climatic conditions of the Cerrado. In this context, the objective of this study was to quantify litter biomass and estimate nutrient and carbon stocks in an agroforestry system composed of baru (Dipteryx alata), banana (Musa sp.), and coffee (Coffea arabica), located in Goiânia, Goiás. The accumulated litter was collected in October 2023 at 40 sampling points using 0.0625 m² sampling frames and separated into leaf, branch, and miscellaneous fractions. After drying, the dry biomass of the fractions was determined, and composite samples were subjected to chemical analysis to determine the concentrations of macro- and micronutrients. Nutrient stocks were calculated based on the biomass and the respective concentrations, and the carbon stock was estimated by applying a factor of 0.43 to the dry biomass. Weather conditions during the period were characterized using data on precipitation, temperature, relative humidity, and wind speed. The total biomass of accumulated litter was 10,922.40 kg ha^{-1}, with the leaf fraction predominating (8,938.72 kg ha^{-1}), followed by miscellaneous material (1,183.20 kg ha^{-1}) and branches (800.48 kg ha^{-1}). In the leaf fraction, the highest macronutrient stocks were observed for N (134.08 kg ha^{-1}), Ca (107.26 kg ha^{-1}), and K (53.63 kg ha^{-1}). The estimated total carbon stock in the litter was 4,696.63 kg C ha^{-1}, concentrated mainly in the leaf fraction. The results highlight the importance of litter as a compartment for biomass, nutrients, and carbon in the agroforestry system studied.
Keywords: Accumulated litter; nutrient cycling; carbon stock; agroforestry system; Cerrado.

RESUMO
A ciclagem de nutrientes e o estoque de carbono na serapilheira constituem processos importantes para a manutenção da funcionalidade dos sistemas agroflorestais, especialmente sob as condições climáticas do Cerrado. Nesse contexto, este estudo teve como objetivo quantificar a biomassa de serapilheira e estimar os estoques de nutrientes e carbono em um sistema agroflorestal composto por baru (Dipteryx alata), banana (Musa sp.) e café (Coffea arabica), localizado em Goiânia, Goiás. A serapilheira acumulada foi coletada em outubro de 2023, em 40 pontos amostrais, utilizando-se gabaritos de 0,0625 m², e separada nas frações folha, galho e miscelânea. Após secagem, determinou-se a biomassa seca das frações, e amostras compostas foram submetidas à análise química para determinação das concentrações de macro e micronutrientes. Os estoques de nutrientes foram calculados a partir da biomassa e das respectivas concentrações, e o estoque de carbono foi estimado aplicando-se o fator 0,43 à biomassa seca. As condições

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meteorológicas do período foram caracterizadas por meio de dados de precipitação, temperatura, umidade relativa do ar e velocidade do vento. A biomassa total de serapilheira acumulada foi de 10.922,40 kg ha⁻¹, com predominância da fração folha (8.938,72 kg ha⁻¹), seguida por miscelânea (1.183,20 kg ha⁻¹) e galho (800,48 kg ha⁻¹). Na fração folha, os maiores estoques de macronutrientes foram observados para N (134,08 kg ha⁻¹), Ca (107,26 kg ha⁻¹) e K (53,63 kg ha⁻¹). O estoque total estimado de carbono na serapilheira foi de 4.696,63 kg C ha⁻¹, concentrado principalmente na fração folha. Os resultados evidenciam a importância da serapilheira como compartimento de biomassa, nutrientes e carbono no sistema agroflorestal estudado.
Palavras-chave: Serapilheira acumulada; ciclagem de nutrientes; estoque de carbono; sistema agroflorestal; Cerrado.

Introduction

Currently, the search for more sustainable and environmentally sound production systems has spurred the adoption and evaluation of diverse forms of land use, among which agroforestry systems stand out due to their potential to integrate productive, environmental, and socioeconomic aspects (Aaron *et al.* 2024). In this context, the sustainability of production systems must take into account their technical efficiency, environmental suitability, economic viability, and social acceptance (Balbino *et al.* 2011).

Agroforestry systems (AFS) integrate agricultural and forestry components within the same area, reconciling the production of food, energy, and ecosystem services with forestry production, thereby promoting water infiltration into the soil, restoring soil fertility, reducing erosion, sequestering carbon in plant biomass, and producing local organic materials, thereby contributing to nutrient cycling, among other benefits (Garcia *et al.* 2021).

Nutrient cycling through the production and decomposition of litter is an important process for transferring these nutrients to the soil. In intercropping systems, the decomposition of organic matter represents a form of synergy and complementarity among biotic components, benefiting nutrient cycling within the system and enabling more efficient use of available resources (Abreu *et al.* 2020). Litter deposition on the soil can be influenced by various factors, such as vegetation type, climatic factors, the alternation between dry and rainy periods, wind, as well as the spatial arrangement and age of the tree component in the system (Carvalho *et al.* 2019).

Thus, characterizing meteorological conditions, combined with an assessment of nutrient stocks in the litter, can contribute to a better understanding of the biogeochemical dynamics and functioning of agroforestry systems, as well as provide a basis for improving management practices better suited to Cerrado conditions.

Given this context, considering the importance of litter for nutrient cycling and carbon stock, and the need to expand our understanding of these processes in agroforestry systems in the Cerrado, this study aimed to quantify litter biomass and estimate nutrient and carbon stocks in an agroforestry system (AFS) established in the Cerrado region of Goiás, taking into account the meteorological conditions during the study period. The AFS, located at the School of Agronomy of the Federal University of Goiás (UFG), consists of baru (*Dipteryx alata*), banana (*Musa* sp.), and coffee (*Coffea arabica*).

Materials and Methods

Characterization of the Study Area

The study was conducted in an agroforestry system located at the School of Agronomy of the Federal University of Goiás (UFG), in the municipality of Goiânia, Goiás, at the geographic coordinates 16°35'58.96" S and 49°16'49.55" W, at an elevation of 741.48 m. The region is part of the Cerrado biome and has a seasonal tropical climate, classified as Aw according to the Köppen classification, with historical averages that characterize its climatic dynamics: average annual precipitation of approximately 1,500 mm, concentrated in the summer; average annual temperature of 22.5 °C (Casaroli *et al.* 2018). The soil is classified as Red Latosol, typical of the Cerrado, with good depth and drainage. For this study, data on cumulative precipitation, average temperature, relative humidity, and average wind speed were considered to characterize the meteorological conditions during the study period.

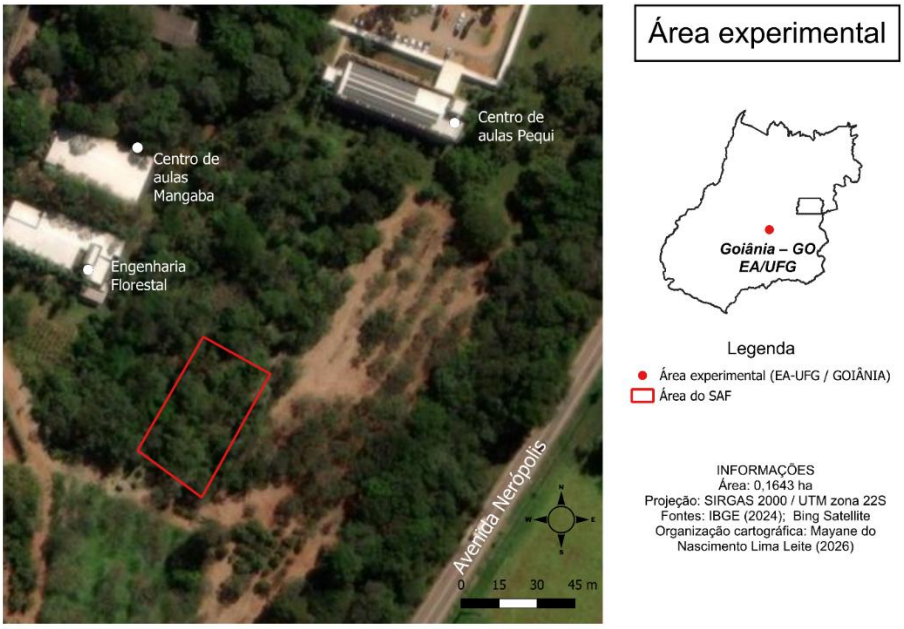


Figure 1 – Location and boundaries of the experimental area at the School of Agronomy of the Federal University of Goiás. Source: prepared by the authors, 2026.

The SAF was established in 2006 by planting agronomic species within a baruzeiro orchard. The orchard consists of 84 baruzeiro trees, arranged in six rows of 14 trees, with a spacing of 6 m between rows and 3 m between trees. Between 2010 and 2018, various agronomic species were cultivated as cover crops, such as *Cajanus cajan*, *Crotalaria* spp., *Canavalia ensiformis*, *Stylosanthes* spp., *Manihot* sp., and *Megathyrsus maximus*, in addition to agricultural crops such as *Zea mays*, *Pennisetum americanum*, and *Vigna unguiculata*. In 2015, banana plants (*Musa* sp.) were planted between the rows of baru trees, with an approximate spacing of 6 m between rows and 2 m between plants. In 2020, coffee plants (*Coffea arabica* L.) were introduced between the rows of baruzeiro trees and banana plants, with a spacing of 3 m between rows and 1 m between plants (Figure 2). In 2017, the baruzeiro trees were pruned, with branches adjacent to the main trunk removed up to half the trees' total height. This management practice resulted in the removal of approximately 50% of the canopy and an increase in sunlight penetration within the agroforestry system (AFS). Currently, the trees have an average height of 9.2 m.

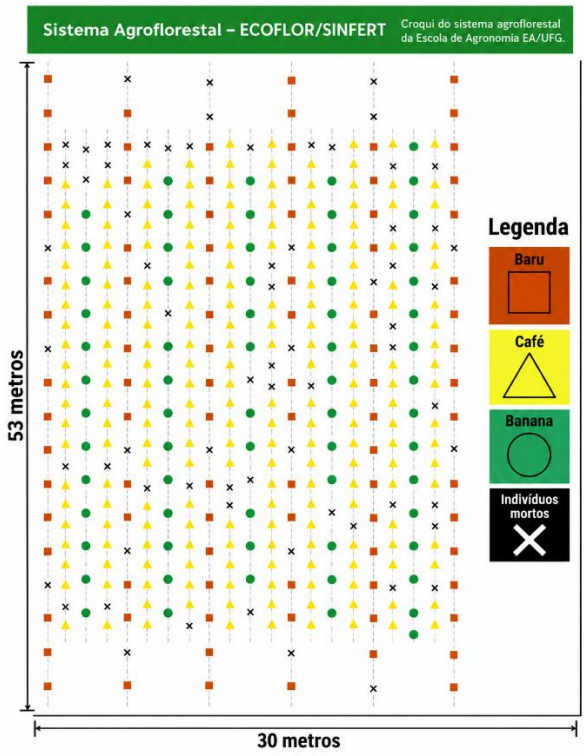


Figure 2 – Spatial arrangement of the species comprising the agroforestry system (AFS) under study. Source: Calil *et al.* (2024).

Characterization of Weather Conditions

Since the samples were collected on October 23, 2023, precipitation records for the days preceding the sampling were reviewed. Precipitation of 10.0 mm was recorded on October 20 and 5.0 mm on October 21, while no precipitation was recorded on October 22 and 23.

To characterize weather conditions during the study period, data from the Goiânia Automatic Weather Station (A002) of the National Institute of Meteorology (INMET) were used, covering the period from August 13 to December 31, 2023. The following variables were considered: accumulated precipitation, average air temperature, relative humidity, and average wind speed. The data were organized by month and used descriptively, as shown in Table 1.

Table 1 – Weather conditions recorded from August through December 2023 at the Goiânia Automatic Weather Station (A002)

Period	*Precipitation (mm)*	*Average air temperature (°C)*	*Relative humidity (%)*	*Wind speed (m s^{-1})*
August 13–31, 2023	18.6	24.25	53.09	0.95
September 2023	37.4	26.98	50.62	0.99
October / 2023	77.6	27.60	58.47	0.88
November / 2023	170.4	27.04	60.38	0.94
December / 2023	218.4	25.89	67.62	0.86
Total / Period Average	***522.4***	***26.52***	***58.49***	***0.92***

Source: Compiled by the authors (2026), based on data from the Goiânia Automatic Weather Station (A002), National Institute of Meteorology (INMET), for 2023.

Sampling

Litter samples were collected on October 23, 2023, at a total of 40 sampling points randomly distributed throughout the agroforestry system. At each point, a 25 x 25 cm (0.0625 m²) sampling frame was used, and all material deposited on the soil surface within the area delimited by the template was collected.

The samples were individually packaged in properly labeled paper bags and sent to the Plant Ecology Laboratory (Ecoflor) at the School of Agronomy of the Federal University of Goiás (UFG). The material was dried in a forced-air oven at 65 °C for approximately 72 hours until it reached a constant mass.

After drying, each sample was separated into three fractions: leaves, branches, and miscellaneous material, the latter consisting of fruits, flowers, animal waste, and other unidentified materials. The fractions of each sample were weighed individually and then grouped by category to obtain three composite samples corresponding to leaves, branches, and miscellaneous material. The dry mass values were recorded in a spreadsheet.

Estimation of Biomass, Carbon Stock, and CO_2 Equivalent

The accumulated dry biomass of the litter was estimated for each fraction based on the average dry mass obtained from the 40 sampling points and the area of the sampling frame used (0.0625 m²). The values were converted to kg ha^{-1} according to Equation 1:

$$Bioac = (Xt \div Ag) \times 10 \quad \text{Eq. 1}$$

Where:
Bio ac: accumulated biomass (kg ha^{-1});
Xt = mass of dry material remaining after drying (g);
Ag = area of the sampling frame (m^2).

Based on the biomass values, the total carbon stock in the litter layer for 1 (one) hectare of agroforestry system was estimated (Equation 2) by multiplying the accumulated dry biomass of each fraction by 0.43, the carbon (C) composition factor for leaf biomass reported by the IPCC[1] (2006), in Volume 4, Chapter 4, Table 4.3. This factor was adopted due to the predominance of the leaf fraction in the sampled material.

$$Ec = Bioac \times 0.43 \quad \text{Eq. 2}$$

Where:
Ec = carbon stock (kg C ha^{-1});
Bio ac = accumulated biomass (kg ha^{-1}).

Carbon dioxide equivalent was calculated from the estimated carbon stock using the conversion factor 44/12 (3.67), based on the ratio of the molecular masses of CO_2 and carbon, as shown in Equation 3 (IPCC 2019). That is, 1 metric ton of carbon is equivalent to 3.67 metric tons of CO_2.

$$Ceq = Ec\ x\ 3.67 \quad \text{Eq. 3}$$

Where:
Ceq = carbon dioxide equivalent (kg CO_2 eq ha^{-1});
Ec = estimated carbon stock (kg C ha^{-1}).

1 The Intergovernmental Panel on Climate Change (IPCC) is the United Nations body responsible for assessing the science related to climate change. Available at: https://www.ipcc.ch/. Accessed in June 2025.

Quantification of Nutrients in the Litter

To determine nutrient concentrations in the litter, the samples were ground in *a Willey-type* knife mill, at the Wood Quality and Bioenergy Laboratory (LQMBio) of the Forest Engineering Department at the Federal University of Goiás (UFG), located in the School of Agronomy, to produce composite samples corresponding to the leaf, branch, and miscellaneous fractions.

Subsequently, the samples were sent to Terra Análises para Agropecuária Ltda. for chemical analysis of plant tissue, conducted according to the methodology described by Malavolta *et al.* (1997). The concentrations of the macronutrients nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), and sulfur (S) were determined and expressed as percentages (%), while the micronutrients copper (Cu), iron (Fe), manganese (Mn), and zinc (Zn) were expressed in mg kg^{-1}.

After obtaining the laboratory results, the nutrient stocks contained in the biomass of each litter fraction were calculated. For the macronutrients, whose concentrations were expressed as a percentage (%), the stock was calculated by multiplying the accumulated biomass of the respective fraction by the nutrient concentration, divided by 100, according to Equation 4:

$$En = BSA \times Cn / 100 \quad \text{Eq. 4}$$

Where:
En = nutrient stock (kg ha^{-1});
BSA = accumulated litter biomass of the respective fraction (kg ha^{-1});
Cn = nutrient concentration in dry matter (%).

For micronutrients, whose concentrations were expressed in mg kg^{-1}, the stocks were calculated by converting mg to kg, according to Equation 5:

$$En = BSA \times Cn / 1{,}000{,}000 \quad \text{Eq. 5}$$

Where:
En = nutrient stock (kg ha^{-1});
BSA = accumulated litter biomass of the respective fraction (kg ha^{-1});
Cn = nutrient concentration in dry matter (mg kg^{-1}).

Results

Accumulated biomass

The total dry mass of the 40 samples was 2,234.68 g for the leaf fraction, 200.12 g for the branch fraction, and 295.82 g for the miscellaneous fraction, corresponding to average dry masses of 55.87 g, 5.00 g, and 7.40 g, respectively. The estimated litter biomass was 10,922.40 kg $^{ha^{-1}}$, with the leaf fraction predominating at 8,938.72 kg $^{ha^{-1}}$ (81.8%), followed by the miscellaneous fraction, with 1,183.20 kg $^{ha^{-1}}$ (10.8%), and the branch fraction, with 800.48 kg ha^{-1} (7.3%) (Figure 3).

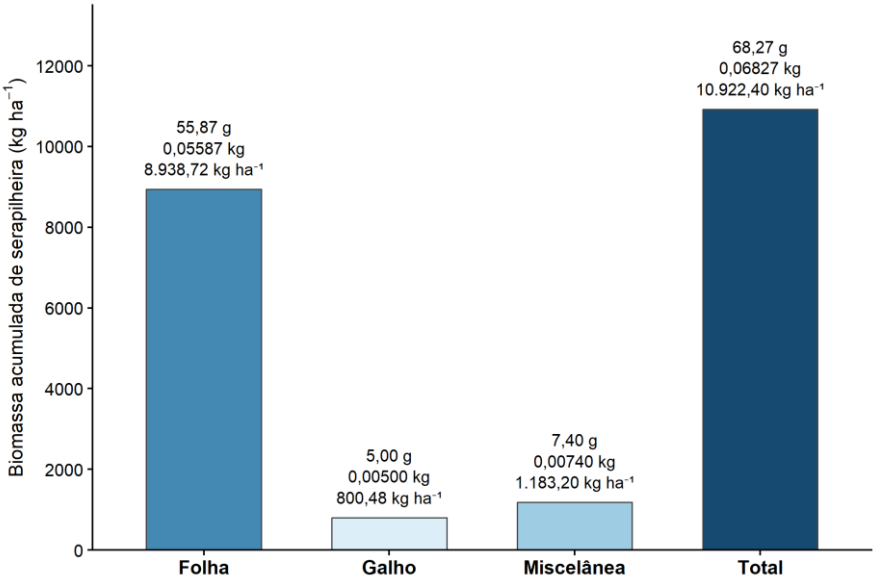


Figure 3 – Estimated accumulated biomass of the litter and its fractions. Source: prepared by the authors, 2026.

Nutrient Stocks

Nutrient stocks differed among the litter fractions (Table 2). In the leaf fraction, which had the highest biomass, the highest macronutrient stocks were observed for N (134.08 kg ha^{-1}), Ca (107.26 kg ha^{-1}), and K (53.63 kg ha^{-1}), followed by Mg (20.56 kg ha^{-1}), P (8.94 kg ha^{-1}), and S (8.04 kg ha^{-1}). Among the micronutrients in the leaf fraction, the highest stocks were observed for Fe (8.49 kg ha^{-1}) and Mn (3.24 kg ha^{-1}).

In the branch fraction, the highest stocks were recorded for Ca (11.21 kg ha^{-1}) and N (8.81 kg ha^{-1}), while in the miscellaneous fraction, N (9.47 kg ha^{-1}), Ca (6.86 kg ha^{-1}), and K (4.73 kg ha^{-1}) predominated.

Table 2 – Nutrient stocks in the different litter fractions of the agroforestry system

Nutrient	*Leaf (kg ha^{-1})*	*Branches (kg ha^{-1})*	*Miscellaneous (kg ha^{-1})*
Nitrogen	134.08	8.81	9.47
Phosphorus	8.94	0.64	0.95
Potassium	53.63	1.60	4.73
Calcium	107.26	11.21	6.86
Magnesium	20.56	2.40	1.77
Sulfur	8.04	0.24	0.24
Copper	0.22	0.03	0.03
Iron	8.49	1.28	2.13
Manganese	3.24	0.12	0.22
Zinc	0.86	0.06	0.12

Source: Compiled by the authors, 2026.

Carbon stock, CO_2 equivalent, and C:N ratio

The total estimated carbon stock in the litter layer was 4,696.63 kg C ha^{-1}, corresponding to 17,236.64 kg CO_2 eq ha^{-1}. The largest contribution to these stocks came from the leaf fraction, due to its greater share of the accumulated biomass. The estimated C:N ratio was 28.67 for leaves, 39.09 for branches, and 53.73 for miscellaneous material, while the value calculated for the litter layer as a whole was 30.82 (Table 3).

Table 3 – Accumulated biomass, carbon stock, CO_2 equivalent, and C:N ratio in litter fractions

Fraction	*Biomass (kg ha^{-1})*	*Carbon (kg ha^{-1})*	*CO_2eq (kg ha^{-1})*	*Ratio C:N*
Leaf	8,938.72	3,843.65	14,106.19	28.67
Branch	800.48	344.21	1,263.24	39.09
Miscellaneous	1,183.20	508.78	1,867.21	53.73
TOTALS	10,922.40	4,696.63	17,236.64	30.82

Source: Compiled by the authors, 2026.

Discussion

The results indicate a predominance of the leaf fraction in the accumulated litter, accounting for 81.8% of the total biomass, which reflects the importance of this fraction for nutrient cycling and the supply of organic matter to the soil in the study area. This fraction also contained the highest nutrient stocks, particularly nitrogen, calcium, and potassium. This observed pattern is consistent with the importance of leaves in nutrient transfer between vegetation and soil, since litter deposition and decomposition are key mechanisms of nutrient cycling in forest and agroforestry ecosystems (Giweta 2020). Ribeiro *et al.* (2017) observed, in Cerrado forest formations, a high proportion of N and Ca in the nutritional composition of litter, although the order of nutrient concentrations varied across phytophysiognomies and seasons. Thus, the compartmentalization of biomass observed in this study constitutes a temporary nutrient reservoir, from which nutrients are gradually released into the system during the litter decomposition process (Pimenta *et al.* 2011).

The distribution pattern of macronutrients in the leaf fraction showed the following descending order: N > Ca > K > Mg > P > S. The highest stocks were observed for N and Ca, followed by K, which is similar to the patterns observed in other studies of litter in forest formations and agroforestry systems. When assessing nutrient stocks in litter across different phytophysiognomies of the Cerrado in the Federal District during the rainy season, Ribeiro *et al.* (2017) observed the sequence N > Ca > K > Mg > S > P in gallery forests and eucalyptus plantations. In the Cerrado of Goiás, Carvalho *et al.* (2019) also observed differences in nutrient distribution among vegetation types and litter fractions, demonstrating that the nutritional composition of this material can vary depending on vegetation characteristics. These variations may be related to the nutritional characteristics of the plant material, species composition, and differences in the absorption, utilization, and redistribution of nutrients by plants. Thus, the pattern observed in the agroforestry system (SAF) composed of baru (*Dipteryx alata*), banana (*Musa* sp.), and coffee (*Coffea arabica*) highlights the importance of plant species diversity in the nutritional composition of the litter and in the potential return of nutrients to the system.

The difference observed in nutrient stocks among litter fractions may be related to the characteristics of the plant material that makes up the agroforestry system, which consists of species such as baru, banana, and coffee. The diversity of plant components promotes the formation of a litter layer that is heterogeneous in terms of the composition and quality of the accumulated material, which may result in different patterns of nutrient accumulation and cycling. The decomposition and release of nutrients from litter are regulated by various factors, including the chemical composition of the material, environmental factors, and the activity of decomposer organisms (Giweta 2020). Thus, the differences observed between the leaf, branch, and miscellaneous fractions in the present study underscore the importance of considering the composition of litter fractions when assessing nutrient cycling in agroforestry systems.

The leaf fraction, as it constitutes the largest fraction of the litter, also contained the highest estimated carbon stock, corresponding to 3,843.65 kg C ha^{-1}. In addition to serving as a temporary reservoir of carbon and nutrients, the litter layer influences the soil-atmosphere relationship, contributing to soil surface protection and the maintenance of organic matter. In integrated systems, the accumulation and decomposition of this material represent important mechanisms for the transfer of carbon and nutrients between vegetation and the soil. Tapia-Coral *et al.* (2005), when assessing carbon and nutrient stocks in litter in agroforestry systems in the Central Amazon, also highlighted the importance of this compartment in carbon and nutrient dynamics. In this regard, the predominance of the leaf fraction observed in the present study reinforces its relevance as a component of the litter and as a temporary reservoir of carbon and nutrients in the AFS.

The estimated C:N ratio also differed among litter fractions, with values of 28.67 for leaves, 39.09 for branches, and 53.73 for miscellaneous material. This ratio is an important indicator of the quality of plant material and of the potential for decomposition and nitrogen release, since the carbon-to-nitrogen ratio influences the activity of decomposer organisms and the processes of nitrogen mineralization and immobilization. In general, materials with lower C:N ratios present more favorable conditions for decomposition and nitrogen mineralization, while higher ratios may favor microbial immobilization and temporarily limit nitrogen availability (Pei *et al.* 2019). Therefore, the lower C:N ratio observed in the leaf fraction suggests greater potential for decomposition and nitrogen cycling compared to the other fractions, while the higher values observed in the branch and, especially, in the miscellaneous fraction indicate materials that are potentially less favorable for the rapid release of this nutrient. However, this interpretation reflects a potential associated with the material's composition, since the decomposition rate and dynamics of N mineralization were not directly determined in this study.

The miscellaneous fraction, consisting of fruits, flowers, animal waste, and other unidentified materials, had a composition distinct from that of the other fractions. Although it accounted for a smaller proportion of the accumulated biomass compared to leaves, it contributed to the macro- and micronutrient stock in the system. The heterogeneity of the materials comprising this fraction may result in distinct chemical characteristics and decomposition patterns, since the quality of plant material is one of the determining factors in decomposition dynamics and nutrient release (Giweta 2020). Thus, the presence of litter increases the diversity of organic materials on the soil surface and contributes to the nutrient cycling dynamics within the system.

The estimated carbon stock in the litter was 4,696.63 kg C ha^{-1}, corresponding to 17,236.64 kg CO_2 eq ha^{-1}, highlighting the contribution of this compartment as a temporary carbon reservoir in the SAF. Although it represents only a fraction of the carbon stored in the system, the litter layer serves as an important link between accumulated biomass and the soil, since part of the carbon present in the deposited material can be incorporated into soil organic matter during the decomposition process. The distribution of carbon among tree biomass, litter, and soil in agroforestry systems varies depending on the system's composition, age, and management, highlighting the importance of jointly assessing these compartments (Lenci *et al.* 2022). Thus, the values obtained in this study should be interpreted as the estimated carbon stock and CO_2 equivalent in the litter accumulated at the time of sampling; they do not correspond to the total carbon stock or carbon sequestration of the entire agroforestry system.

The distribution of carbon among litter fractions directly mirrored each fraction's share of the accumulated biomass, since the carbon stock was estimated based on dry biomass. In this context, the predominance of the leaf fraction resulted in its largest contribution to the estimated carbon stock, while branches and miscellaneous material accounted for proportionally smaller shares. This distribution underscores the importance of considering litter composition when interpreting carbon stocks in agroforestry systems. In addition to the quantity of accumulated material, differences in the C:N ratio among the fractions indicate distinct qualitative characteristics of the residues present on the ground. The association between the quantity and quality of the material is relevant for understanding the dynamics of this compartment, since litter decomposition contributes to the transfer of carbon and nutrients to the soil (Giweta 2020). However, the observed stock represents a specific condition at the time of sampling and does not allow for a direct determination of carbon persistence in this compartment. As highlighted by Lenci *et al.* (2022), the assessment of carbon in agroforestry systems involves different compartments, including tree biomass, litter, and soil. Thus, the quantification performed in this study helps to specifically characterize the litter compartment, providing a basis for future assessments that integrate other carbon reservoirs and samplings at different times of the year.

The retention of litter on the soil surface plays a significant role in agroforestry systems, as it provides physical protection for the soil, contributes to nutrient cycling, and helps maintain organic matter. The diversity of plant components in the system also promotes the formation of litter with diverse chemical and structural characteristics, resulting in greater heterogeneity of the accumulated biomass. In addition to nutrient cycling, the presence of litter can help retain moisture and provide protection against erosion, which are important characteristics in environments subject to seasonal climate variations, such as the Cerrado (Nair 2011; Altieri 2012). In the evaluated SAF, the nutrient and carbon stocks found in the litter layer highlight the importance of this compartment in the biogeochemical dynamics of the system; however, studies involving seasonal sampling and decomposition assessments are needed to determine how these stocks vary over time and in response to climatic and environmental variations.

Final Considerations

The litter accumulated in the agroforestry system was dominated by the leaf fraction, which also accounted for the largest share of carbon and nutrient stocks. Among the macronutrients, nitrogen, calcium, and potassium stocks stood out, highlighting the importance of litter as a nutrient compartment in the system.

The observed values for the C:N ratio among leaves, branches, and miscellaneous material indicate distinct qualitative characteristics among the fractions and different potentials for decomposition and nitrogen release. However, since decomposition and mineralization were not directly assessed, these results should be interpreted as indicators of the fractions' potential behavior.

The carbon stock in the litter was estimated at 4,696.63 kg C ha^{-1}, corresponding to 17,236.64 kg ha^{-1} of CO_2 equivalent. These results highlight the contribution of litter as a temporary carbon pool in the agroforestry system, though they do not represent the total carbon stock or carbon sequestration of the entire system.

Taken together, the results demonstrate the role of litter in nutrient cycling and in the biogeochemical dynamics of the system composed of baru, banana, and coffee. Studies involving sampling at different times of the year, combined with an assessment of decomposition rates and the transformations of carbon and nutrients, could enhance our understanding of these processes and their relationship with climatic and environmental conditions in the Cerrado.

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