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# FLORISTIC DIVERSITY IN AGROFORESTRY SYSTEMS IN THE STATE OF RIO DE JANEIRO

## DIVERSIDADE FLORÍSTICA EM SISTEMAS AGROFLORESTAIS NO ESTADO DO RIO DE JANEIRO

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## ABSTRACT

The present article brings together existing plant diversity in agroforestry systems (AFS) in the state of Rio de Janeiro. The survey was carried out with digital databases, using terms in Portuguese and English, such as: "sistemas agroflorestais RJ", "agrofloresta RJ", "agroforestry RJ", and "agroforestry systems RJ", with fourteen AFSs being verified. The species present in the agroforests of Rio de Janeiro were listed when present in at least five of the fourteen AFSs found (35.71%). Fifteen species (8.82%) were among the most common, out of a total of 170 different species found, demonstrating the diversity of AFSs. Plant species are located in the following cities in the state of Rio de Janeiro: Seropédica, Rio de Janeiro, Três Rios, Paraty and Nova Friburgo. The most mentioned species were papaya (*Carica papaya* L.) and annatto (*Bixa orellana* L.). More AFSs were analyzed in the Metropolitan Region within the state of Rio de Janeiro, highlighting the municipality of Seropédica. Agroforests can contribute to the conservation or restoration of plant diversity, while promoting food and nutritional sovereignty and security, community subsistence, and local commercialization, among other benefits.

**Keywords**: Plant diversity. Sustainable Agriculture. Food plants. Atlantic Forest.

## RESUMO

O presente artigo reúne a diversidade vegetal existente em sistemas agroflorestais (SAFs) no estado do Rio de Janeiro. O levantamento foi realizado em bases de dados digitais, utilizando termos em português e inglês, como: "sistemas agroflorestais RJ", "agrofloresta RJ", "agroforestry RJ" e "agroforestry systems RJ", sendo verificados quatorze SAFs. As espécies presentes nas agroflorestas do Rio de Janeiro foram elencadas quando presentes em pelo menos cinco dos quatorze SAFs encontrados (35,71%). Quinze espécies (8,82%) estavam entre as mais comuns, no total de 170 diferentes espécies encontradas, evidenciando a diversidade dos SAFs. As espécies vegetais estão localizadas nas seguintes cidades do estado do Rio de Janeiro: Seropédica, Rio de Janeiro, Três Rios, Paraty e Nova Friburgo. As espécies mais mencionadas foram o mamão (*Carica papaya* L.) e o urucum (*Bixa orellana* L.). A Região Metropolitana foi a região do estado do Rio de Janeiro com mais SAFs analisados, destacando-se o município de Seropédica. As agroflorestas podem contribuir para a conservação ou restauração da diversidade vegetal ao mesmo tempo em que promovem a soberania e segurança alimentar e nutricional, a subsistência da comunidade e a comercialização local, entre outros benefícios.

**Palavras-chave**: Diversidade vegetal. Agricultura sustentável. Plantas alimentícias. Mata Atlântica.

## 1 INTRODUCTION

Agroforestry systems (AFSs) are variously defined. Bene, Beall and Côté (1977), for example, formulated one of the first concepts of agroforestry, still very current, defining an AFS as "a sustainable management system for land that [...] combines agricultural crops, tree crops and forest plants and/or animals simultaneously or sequentially, and applies management practices that are compatible with the cultural patterns of the local population" (BENE; BEALL; CÔTÉ, 1977, p. 39). A more simplistic definition was given by ICRAF (International Center of Research in Agroforestry), indicating AFSs as "combinations of the arboreal element with herbaceous and (or) animals, organized in space and (or) in time" (STEENBOCK *et al.*, 2013, p. 44, our translation).

AFSs have been developed for thousands of years all over the world, especially as traditional agroforestry systems, or TAFS; however, it is only recently, around 50 years ago, that they have become objects of scientific interest (MICCOLIS *et al.*, 2016; VAZQUEZ-DELFIN; CASAS; VALLEJO, 2022). It is necessary to point out the different types of agroforests, from the least complex, with a small number of plant species and low-intensity management, to the most complex, with high diversity of plant species and high-intensity management (MICCOLIS *et al.*, 2016). Compared to monoculture, an agroforest with two plant species, one herbaceous and one arboreal, still represents a simplification of an ecosystem, while a biodiverse agroforest is more like natural tree stands and vegetation (STATON *et al.*, 2022).

In this sense, AFSs could combine production with environmental conservation or recovery (SCHEMBERGUE *et al.*, 2017), as an alternative to industrial agriculture. According to Miccolis *et al.* (2016), the most biodiverse agroforests with similarity to forest ecosystems are called successional or biodiverse agroforests, as defined by the vast diversity of plant species and management based on ecological succession. Ernst Götsch[1] developed and disseminated this type of AFS in Brazil (MICCOLIS *et al.*, 2016).

Biodiverse agroforests have the capacity to conserve agrobiodiversity. According to Reiniger, Wizniewsky and Kaufmann (2017, p. 22-23, our translation), agrobiodiversity is understood, according to the definition adopted at the 5th Conference of the Parties of the Convention on Biological Diversity (CBD), as:

[1] Ernst Götsch is a Swiss farmer and researcher who has lived in Brazil since the early 1980s. He has developed syntropic agriculture that combines agricultural production with environmental recovery.

> a broad term that includes all components of biodiversity that are relevant to agriculture and food, and all components of biodiversity that make up agroecosystems: the variety and variability of animals, plants and micro-organisms, at the genetic, species and ecosystem levels, necessary to sustain the key functions of agroecosystems, their structures and processes (REINIGER; WIZNIEWSKY; KAUFMANN, 2017, p. 22-23, our translation).

It is worth mentioning that AFSs are not necessarily agroecological since agroforestry and agroecological systems are different from one another. However, AFSs can adhere to the principles of agroecology.

Agroecology aims to support the establishment of an agricultural system based on ecology, taking into account the six aspects of sustainability: environmental, social, cultural, political, economic and ethical (REINIGER; WIZNIEWSKY; KAUFMANN, 2017; CORRADO *et al*., 2019). Agroecology is not based on rules, but rather, guiding principles, such as producing an agroecosystem in accordance with the local culture, prioritizing the use of renewable and local natural elements, favoring the cycling of nutrients, prioritizing a diversity of plant species from a functional point of view and maintaining long-term productivity without degrading natural elements (FEIDEN, 2005; ANDRADE; PASINI; SCARANO, 2020).

In syntropic agriculture, sustainability of an agroecosystem depends on its degree of similarity to the natural ecosystem at the place of intervention (GÖTSCH, 1996; ANDRADE; PASINI; SCARANO, 2020). The adoption of agroforestry practices is quite relevant in tropical areas known for their high biological diversity. Currently, adoption of these innovative practices is growing in an attempt to reconcile the principles of agroecology (MCGINTY *et al*., 2008; ANDRADE; PASINI; SCARANO, 2020).

The use of pesticides, fertilizers (chemical or even organic) and heavy machinery should not be adopted in syntropic agriculture (GÖTSCH, 1996). This is because syntropic agricultural systems are designed to produce their own fertilizer to avoid depending on external inputs to fertilize the soil (GÖTSCH, 1997). Agroecosystems aim to resemble the natural ecosystem in order to form an adaptive and balanced environment from an environmental perspective (GUIMARÃES; MENDONÇA, 2019). This environment does not favor the appearance of "pests"; however, if they do appear, they are not seen in a negative way; instead, they indicate an imbalance, and as such, they collaborate with the agroecosystem (GÖTSCH, 1997). Thus, instead of simply eliminating "pests", an appropriate intervention more broadly aims to restore balance to the agroecosystem (GÖTSCH, 1997).

AFSs can be classified in several ways, but the classification based on the combination of their components is most commonly used. For Miccolis *et al*. (2016), this classification includes agrosilviculture systems, silvopastoral systems, and agrosilvopastoral systems. The first is characterized by the association between annual agricultural crops and forest species. The second refers to the combination of trees and pastures, aimed at raising animals. The third refers to consortia between agricultural and forestry species, either simultaneously or sequentially, and the raising of animals (MICCOLIS *et al*., 2016).

AFSs have numerous environmental, economic and social advantages, depending on the context, the type of agroforestry adopted and the management carried out (MICCOLIS *et al*., 2016; SCHEMBERGUE *et al*., 2017). Among their environmental benefits are conserving the soil, providing shade and producing more pleasant microclimates, reducing greenhouse gas emissions, increasing carbon stocks in the soil, conserving fertile soil and water availability, benefiting biological diversity and ecological processes, including the availability of pollinating agents, and mitigating climate change (BHAGWAT *et al*., 2008; MICCOLIS *et al*., 2016; RATHORE *et al*., 2022).

Sustainability guides the activities in AFSs (SOBOLA *et al*., 2015; LAUDARES *et al*., 2017). Social and economic benefits include fostering sovereignty, along with food and nutrition security; increasing efficiency in the use of production factors, such as water, light and nutrients; generating and diversifying income; improving the quality of work and life, as work is carried out in the shade; reducing the demand for external inputs, owing to their optimization (MICCOLIS *et al*., 2016); and contributing to the community's environmental education (KARKI *et al*., 2016; HEMMELGARN *et al*., 2019).

The Atlantic Forest originally covered 12% of Brazil, but, currently, it is only 7%; even so, this biome has broad relevance from an environmental point of view as 70% of the country's population lives within its boundaries (VARJABEDIAN, 2010). The Atlantic Forest is one of the most biologically diverse biomes in the world with approximately twenty thousand different species of plants, eight thousand of which are endemic species (VARJABEDIAN, 2010). It is also one of the most threatened biomes on the planet, a hotspot, demonstrating its importance and need for conservation (VARJABEDIAN, 2010). Reports show constant anthropic activities that interfere with the dynamics of this biome, such as deforestation for civil construction and use for agribusiness, which, in Brazil, represents one of the main sectors of the economy (MELO *et al*., 2013; MANGUEIRA *et al*., 2021).

Given this scenario, sustainable agriculture is fundamental. On the one hand, food production must be increased owing to population growth, while, on the other hand, environmental conservation is important. AFSs in Rio de Janeiro are found in many locations, including town squares, schools, rest homes, "quilombola" communities (ethnic groups whose black ancestry was enslaved by the colonial regime in the 16th century), areas surrounding conservation units, agricultural areas and experimental units. This study aimed to survey and synthesize records of plant diversity in AFSs located in the state of Rio de Janeiro. To accomplish this, published studies were obtained online and reviewed to promote knowledge about these agricultural systems as sustainable alternatives for food production and other uses.

## 2 MATERIAL AND METHODS

Guiding this review, we asked which species are cultivated in AFSs in the state of Rio de Janeiro and where AFSs are located. As suggested above, our AFS survey was carried out in the databases Google Scholar, Scielo, Science Direct, "Periódico Capes" and on the website "Mapa da Agroecologia" (MAPA DA AGROECOLOGIA, s. d.) with the objective of pinpointing areas of agroecology. We used the following keywords: "sistemas agroflorestais RJ", "agrofloresta RJ", "agroforestry RJ", "agroforestry systems RJ", "agrossilvicultura RJ", "agrossilvipastoril RJ", "silvipastoril RJ", "sistemas permaculturais RJ" and "sistema ILPF RJ". We reviewed scientific articles, Course Completion Works, and works presented at conferences about AFSs in the state of Rio de Janeiro with no time constraints. The period containing digital references for the purpose of the research was from 2006 to 2020. Fourteen AFSs were verified.

Some online records reported on experimental areas, and when the same experiment was implemented in AFSs, but with different floristic compositions, both were considered. On the other hand, when the agroforests had the same plant species, either in different locations or in the same location, only one was analyzed. When other types of agricultural production were described in comparative studies, only agroforestry was considered. We excluded papers without scientific nomenclature, or those only citing popular names; duplicate papers, i.e., those found in different databases, thus considering only the first citation; the same AFSs reported in different works and works containing cultivation systems with different characteristics of agroforests. Moreover, not all species were identified in some works, only the genus was identified. In this case, only plants for which the species were identified could be considered. Species with different synonyms were considered only once.

After the survey, information on plant species mentioned and present in at least five of the fourteen (35.71%) agroforests found in the state of Rio de Janeiro was synthesized. In AFSs, we considered the presence of spontaneous species, i.e., those species not planted, but rather the products of spontaneous growth, a common phenomenon.

Data were synthesized in a table containing the most common plant species found in AFSs in the state of Rio de Janeiro and other relevant information. Species listed with medicinal properties of interest to the Unified Health System (Sistema Único de Saúde - SUS) and Non-Conventional Food Plants (Plantas Alimentícias Não Convencionais - PANCs) were also flagged. In addition, a table was constructed to show the number of times that the most mentioned plant species appear and the respective locations of the AFSs.

A map containing agroforests of the state of Rio de Janeiro was prepared using the cartographic bases of the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística - IBGE) and PRODES through the website (BRASIL, s. d.) in ArcMap, version 10.6. The green gradient on the map of the state of Rio de Janeiro shows vegetation cover and indicates fragmented areas with less vegetation (light green) and more vegetation (dark green) of the Atlantic Forest biome.

## 3 RESULTS AND DISCUSSION

The results found for AFSs in the state of Rio de Janeiro are distributed between 2006 and 2020. No digital references relevant to the objective were found prior to 2006. Considering the period up to 2020, the number of digital publications on the subject was low. In Science Direct and "Periódico Capes", no articles were found that suited the research objectives. In the survey carried out on the "Mapa da Agroecologia" website, no agroforestry was found that detailed the scientific names of the species, only the popular names.

Of two limiting factors in the survey, the first involves the number of agroforestry. That is, more AFSs are found in the state of Rio de Janeiro. Nonetheless, scientific publications or other sources of data available online are sparse. In some cases, the scientific name of the species was absent in the studies; therefore, the species could not be validated since the popular name, which carries sociocultural values, tends to vary among different regions of Brazil. Of course, plants of the same genus can have any number of species; e.g., the banana tree, such as *Musa paradisiaca* and *M. sapientum*, among others. The second limitation involves species that may have been introduced, spontaneously or not, in the surveyed AFSs, both before and after their description. Overall, only a few records on AFSs are available on digital databases in the state of Rio de Janeiro, especially details of their floristic composition.

Fifteen (8.82%) common species were found in the fourteen AFSs in the state of Rio de Janeiro, totaling 170 different species. Table 1 summarizes species data, including popular name, scientific name, family, habit, ecological group, life cycle, organs and possible uses. All recorded species belong to the group known as Angiosperms. The AFSs found include the following municipalities in the state of Rio de Janeiro: Seropédica, Rio de Janeiro, Três Rios, Paraty and Nova Friburgo (Figure 1). Environmental conservation and recovery permeate the implementation of AFSs in Rio de Janeiro and demonstrate the commitment of researchers, farmers and civil society to adopt more sustainable practices and conservation/restoration of the Atlantic Forest, along with the necessity of food production. The dissoluton of the Atlantic Forest follows a timeline from colonization to the present day. As a result, we have a very fragmented biome with a reduction in biodiversity and ecosystem services, as evidenced by the map (Figure 1).

In addition, AFSs found are experimental areas of the Brazilian Agricultural Research Corporation (Empresa Brasileira de Pesquisa Agropecuária - EMBRAPA) and the Federal Rural University of Rio de Janeiro (Universidade Federal Rural do Rio de Janeiro - UFRRJ); farmed agricultural areas, both big and small; agroforest implemented in a school for educational purposes; collective agroforests created in a square by the local community; agroforestry in the backyard of a rest home; agroforestry implemented by family farmers in partnership with the Oswaldo Cruz Foundation (Fundação Oswaldo Cruz - FIOCRUZ) around a conservation unit the Pedra Branca State Park (Parque Estadual da Pedra Branca - PEPB); and AFSs in traditional quilombola communities (Table 2).

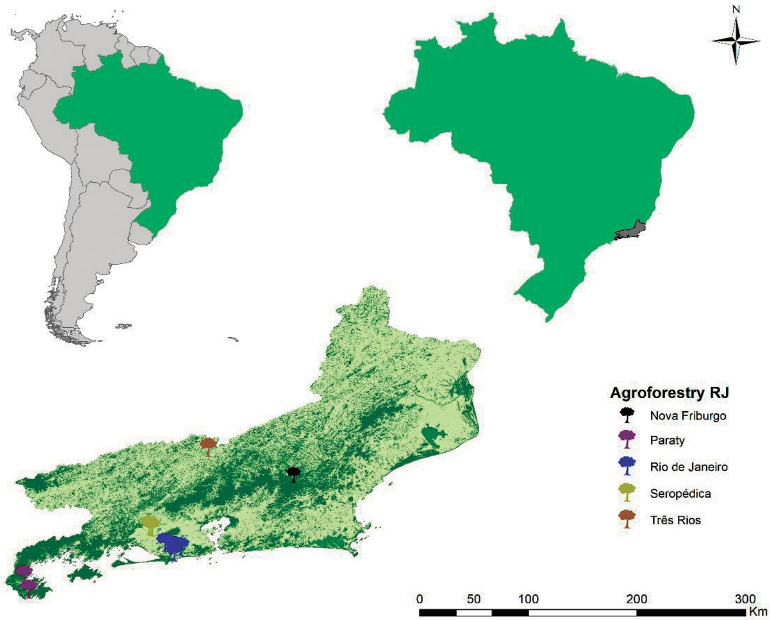
AFSs can be a way of producing food, but also of conserving the ecosystem or recovering degraded areas (MARTINS; RANIERI, 2014). The latter is represented by agroforestry implemented in the town square of Campo Grande in the West Zone of Rio de Janeiro City (Figure 2), as described by Victório and Silva (2020). The AFS consists of species native to the Atlantic Forest, such as Brazilwood (*Paubrasilia echinata* (Lam.) Gagnon, H.C.Lima & G.P.Lewis) and Achiote (*Bixa orellana* L.), and ecological relationships were reconstituted by virtue of promoting greater biological diversity. AFSs can also be a pedagogical and socioenvironmental interaction space.

Table 1 – Floristic diversity in agroforestry systems (AFS) located in the state of Rio de Janeiro, as obtained from a review of studies published between 2006 and 2020

| Family[1] | Popular name | Scientific name | Habit | Life cycle | Parts | Possible uses |
|---|---|---|---|---|---|---|
| Bromeliaceae | Pineapple* | *Ananas comosus* L. Merril | Herbaceous | Annual[3,4,5] | Infructescence | Food; medicinal; attraction of fauna and pollinators[5] |
| Arecaceae | Açaí palm | *Euterpe oleracea* Mart. | Arboreous | Perennial | Fruit, Heart of palm | Heart of palm; food; wildlife[2] |
| Anacardiaceae | Brazilian peppertree*,** | *Schinus terebinthifolia* Raddi | Arboreous | Perennial | Fruit, Leaf, Wood | Condiment (pink pepper); medicinal |
| Fabaceae | Jack bean** | *Canavalia ensiformis* (L.) DC. | Herbaceous | Annual[3,5] | Whole plant | Forager; attraction of fauna and pollinators; biomass producer[5]; green adubation |
| Fabaceae | Pigeon pea** | *Cajanus cajan* (L.) Huth | Shrubby | Biennial[3,5] | Seed, Leaf | Food; medicinal; forage; attraction of fauna and pollinators; biomass producer[5]; green adubation |
| Fabaceae | Gliricidia | *Gliricidia sepium* (Jacq.) Kunth ex Walp. | Arboreous | Perennial | Leaf | Forager; medicinal; attraction of fauna and pollinators; biomass producer[5]; green adubation; animal feed; shading[2] |
| Annonaceae | Soursop | *Annona muricata* L. | Arboreous | Perennial | Fruit | Food; medicinal; attraction of fauna and pollinators[5] |
| Fabaceae | Brazilian firetree | *Schizolobium parahyba* (Vell.) Blake | Arboreous | Perennial | Seed, Stem (wood) | Ornamental; craftsmanship; lumber for various purposes, such as canoe production |
| Fabaceae | Ice cream bean** | *Inga edulis* Mart. | Arboreous | Perennial | Stem, Fruit, Flower | Food; medicinal; biomass producer; forage; attraction of fauna and pollinators[5]; beekeeping; lumber[2] |
| Fabaceae | Brazilian copal | *Hymenaea courbaril* L. | Arboreous | Perennial | Stem, Fruit | Lumber; food; medicinal; attraction of fauna and pollinators[5] |
| Arecaceae | Juçara palm | *Euterpe edulis* Mart. | Arboreous | Perennial | Heart of palm, Fruit | Food; attraction of fauna and pollinators[5]; heart of palm; ornamental[2] |
| Caricaceae | Papaya | *Carica papaya* L. | Shrubby | Biennial[5] Perennial[3] | Fruit | Food; medicinal; attraction of fauna and pollinators[5] |
| Euphorbiaceae | Cassava | *Manihot esculenta* Crantz | Shrubby | Annual[3,4] | Root | Food |
| Myrtaceae | Brazilian cherry | *Eugenia uniflora* L. | Shrubby | Perennial | Fruit | Beekeeping; food; lumber; medicinal; wildlife[2] |
| Bixaceae | Achiote | *Bixa orellana* L. | Shrubby | Perennial | Seed | Biomass producer; paprika; condiment; lumber; repellent[2]; food; medicinal; attraction of fauna and pollinators[5] |

Source: Prepared by the authors with data from Reflora (s. d.); Nóbrega (2006); Peneireiro e Brilhante (2010); Steenbock e Vezzani (2013); Miccolis *et al*. (2016).
* National List of Medicinal Plants of Interest to Unified Health System (Sistema Único de Saúde - SUS).
** Non-conventional Food Plants (Plantas Alimentícias Não Convencionais – PANC), according to the classification of Kinupp and Lorenzi (2014).

Figure 1 – Map containing the location of agroforestry systems (AFSs) distributed in different cities in the state of Rio de Janeiro




Source: Prepared by the authors (2023) based on data from IBGE and PRODES Brasil. ArcMap 10.6.

Table 2 – Geographic coordinates of the agroforestry systems (AFSs) in the state of Rio de Janeiro, as indicated on the map (Figure 1)

| AFSs | Cities | Longitude | Latitude |
|---|---|---|---|
| National Center of Agrobiology Research at the EMBRAPA | Seropédica | 43°42'0"W | 22°45'0"S |
| Technical School of UFRRJ | | 43°40'38"W | 22°46'10"S |
| "Fazendinha Agroecológica" of EMBRAPA | | 43°41'0"W | 22°46'0"S |
| Experimental area of UFRRJ | | 43°42'0"W | 22°45'36"S |
| "Fazendinha Agroecológica" of EMBRAPA | | 43°41'0"W | 22°45'0"S |
| Quilombola community of Campinho da Independência | Paraty | 44°42'0"W | 23°17'0"S |
| Farm Goura Vrindávna | | 44°44'13"W | 23°09'52"S |
| Rest home São Vicente | Três Rios | 43°12'42"W | 22°06'41"S |
| Small farm Abaetetuba | Nova Friburgo | 42°30'15"W | 22°20'14"S |

| AFSs | Cities | Longitude | Latitude |
|---|---|---|---|
| Square (Campo Grande) | Rio de Janeiro | 43°34'20"W | 22°53'50"S |
| Surroundings of the PEPB of Rio da Prata (Campo Grande) | | 43°30'58"W | 22°54'58"S |
| Surroundings of the PEPB of Vargem Grande | | 43°29'38"W | 22°58'33"S |
| Surroundings of the PEPB of Pau da Fome (Jacarepaguá) | | 43°26'26"W | 22°55'54"S |

Source: Prepared by the authors, 2023.

Figure 2 – Agroforestry System (AFS) implemented by popular initiative in a square in Campo Grande, West Zone, Rio de Janeiro City

Source: First author, 2019.

Table 1 presents the number of times that each species, among the most cited, is present in AFSs located in the state of Rio de Janeiro, along with locations and works consulted.

Table 1 – Quantity and location of common species in agroforestry systems (AFSs) in the state of Rio de Janeiro and the respective works in which they were cited

| Popular name | Number of AFSs* | Cities** | Reference |
|---|---|---|---|
| Pineapple | 5 | Rio de Janeiro, Seropédica, Nova Friburgo, Paraty. | Nóbrega (2006); Silveira *et al*. (2007); Gomes *et al*. (2009); Santos *et al*. (2015); Victório e Silva (2020). |
| Açaí palm | 8 | Seropédica, Paraty. | Nóbrega (2006); Silveira *et al*. (2007); Paula *et al*. (2015); Santos *et al*. (2015); Oliveira (2016); Rossi *et al*. (2016). |
| Brazilian peppertree | 6 | Rio de Janeiro, Seropédica, Paraty. | Silveira *et al*. (2007); Marins *et al*. (2013); Santos *et al*. (2015); Bieluczyk *et al*. (2018); Victório e Silva (2020). |
| Jack bean | 8 | Rio de Janeiro, Seropédica, Paraty. | Silveira *et al*. (2007); Silva *et al*. (2012); Marins *et al*. (2013); Santos *et al*. (2015); Oliveira (2016); Victório e Silva (2020). |
| Pigeon pea | 5 | Rio de Janeiro, Seropédica, Paraty. | Silveira *et al*. (2007); Silva *et al*. (2012); Santos *et al*. (2015); Victório e Silva (2020). |
| Gliricidia | 8 | Seropédica, Paraty. | Nóbrega (2006); Silveira *et al*. (2007); Paula *et al*. (2015); Santos *et al*. (2015); Oliveira (2016); Bieluczyk *et al*. (2018). |
| Soursop | 5 | Seropédica, Nova Friburgo, Paraty. | Nóbrega (2006); Silveira *et al*. (2007); Gomes *et al*. (2009); Silva *et al*. (2012). |
| Brazilian firetree | 5 | Rio de Janeiro, Seropédica, Nova Friburgo, Paraty. | Nóbrega (2006); Gomes *et al*. (2009); Silva *et al*. (2012); Rossi *et al*. (2016); Victório e Silva (2020). |
| Ice cream bean | 5 | Seropédica, Nova Friburgo, Paraty. | Nóbrega (2006); Silveira *et al*. (2007); Gomes *et al*. (2009). |
| Brazilian copal | 6 | Seropédica, Nova Friburgo, Paraty. | Nóbrega (2006); Silveira *et al*. (2007); Gomes *et al*. (2009); Silva *et al*. (2012); Santos *et al*. (2015). |
| Juçara palm | 6 | Seropédica, Nova Friburgo, Paraty. | Nóbrega (2006); Silveira *et al*. (2007); Gomes *et al*. (2009); Rossi *et al*. (2016). |
| Papaya | 11 | Rio de Janeiro, Seropédica, Nova Friburgo, Paraty, Três Rios. | Nóbrega (2006); Silveira *et al*. (2007); Gomes *et al*. (2009); Silva *et al*. (2012); Santos *et al*. (2015); Rossi *et al*. (2016); Cortines, Lopes e Almeida (2017); Victório e Silva (2020). |
| Cassava | 6 | Rio de Janeiro, Nova Friburgo, Paraty. | Silveira *et al*. (2007); Gomes *et al*. (2009); Silva *et al*. (2012); Victório e Silva (2020). |
| Brazilian cherry | 7 | Rio de Janeiro, Seropédica, Nova Friburgo, Paraty, Três Rios. | Nóbrega (2006); Silveira *et al*. (2007); Gomes *et al*. (2009); Marins *et al*. (2013); Cortines, Lopes e Almeida (2017). |
| Achiote | 9 | Rio de Janeiro, Seropédica, Nova Friburgo, Paraty. | Nóbrega (2006); Silveira *et al*. (2007); Gomes *et al*. (2009); Silva *et al*. (2012); Rossi *et al*. (2016); Bieluczyk *et al*. (2018); Victório e Silva (2020). |

*Number of AFSs where the species is present.
**Cities in RJ where the species were found.
Source: Prepared by the authors, 2023.

It is important to point out that two articles described more than one AFS, in other words, agroforestry with different floristic compositions. One article cited 2 AFSs and the other 3 AFSs. In these two cases, all agroforestry were considered. Therefore, the number of AFSs does not necessarily correspond to the number of researched materials.

The plants chosen for an AFS can vary according to a number of factors: the farmers' objective; environmental conditions, such as climate, soil, water and light; market conditions, such as accessibility and proximity; access to external inputs, such as seeds, seedlings, machines, tools, irrigation and fertilizers; and the availability of workers (SÃO PAULO, 2018).

AFSs can generate income (oriented toward trade); restore the environment by providing ecosystem services, or ensure food security for farmers, more than one of these objectives may be present (SÃO PAULO, 2018; RATHORE *et al*., 2022). If the objective is economic, a species with commercial importance can be introduced; if it is for recovery, species can be planted with the aim of improving soil fertility; if it is for subsistence, the species are chosen according to the eating habits of the farming family (SCHEMBERGUE *et al*., 2017; SÃO PAULO, 2018).

In addition to these factors, plant species are selected according to the agroforestry arrangement chosen. For example, if it is a successional agroforestry, the stratum and life cycle of each species must be taken into account to set up consortia (MARTINS; RANIERI, 2014; SÃO PAULO, 2018). With regard to consortia, species that complement each other should be selected, e.g., plants with roots that reach different depths.

It is worth mentioning the diversity of plants with food potential that are unknown by the population and therefore called "non-conventional food plants" (PANCs), many of which develop spontaneously and are sometimes referred to as weeds (KINUPP; LORENZI, 2017). PANCs are a possible nutritional and functional source for human food. At least 3,000 species of PANCs are found in Brazil (KELEN *et al*., 2015). According to data from the Food and Agriculture Organization of the United Nations (FAO), plant species consumed by humans have dramatically decreased (LIRA, 2018). For FAO, in the last hundred years, it is estimated that the number of species consumed has dropped from 10,000 to just 170 (LIRA, 2018).

These plants are probably ignored in many studies on plant diversity in agroecosystems, including AFSs, although PANCs are common in agroforests, especially agroecological ones, either spontaneously or planted. Among the most common plant species in agroforestry in the state of Rio de Janeiro, some PANCs can be found, such as the fast-growing Brazilian peppertree (*S. terebinthifolius*), jack bean (*C. ensiformis*), pigeon pea (*C. cajan*) and ice cream bean (*I. edulis*), considered green manures. Ice cream bean provides several benefits to the community and is therefore frequently found in different AFSs. These observations highlight the importance of agroforests for agrobiodiversity.

It should be noted that food plants, such as banana tree and citrus tree, were not among the most common species in AFSs in the state of Rio de Janeiro. Since species identification of these plants is difficult and the present study chose to disregard plants only classified by genus. However, such plants appeared frequently in the works reviewed. For instance, banana (*Musa* sp.) and citrus (*Citrus* sp.) are cited in AFSs located in the cities of Rio de Janeiro, Seropédica and Paraty.

## 4 CONCLUSIONS

Fifteen (8.82%) species were present in at least five of the fourteen AFSs found in the state of Rio de Janeiro. In total, fourteen (35.71%) agroforests were comprised of 170 different species, demonstrating the diversity of species found in agroforests. Among the AFSs analyzed, plant diversity brought together between 7, the least diverse agroforestry, and 57 species, the most diverse. Even within the same AFS, different species of acacia tree (*Acacia angustissima*, *A. mangium* and *A. holocericia*), trumpet tree (*Tabebuia avellanedae* and *T. alba*), spurflower (*Plectranthus barbatus* and *Peumus boldus*) and bean (*Phaseolus vulgaris*, *C. ensiformis* and *C. cajans*) were found.

The most cited species were papaya (*C. papaya*) and achiote (*B. orellana*), and the region of the state of Rio de Janeiro with the most AFSs was the Metropolitan Region with emphasis on the municipality of Seropédica. As already mentioned, an agroecosystem will be more sustainable as it approaches the natural ecosystem state. One of nature's strategies to maintain balance is to favor biodiversity. In this sense, biodiverse agricultural systems contribute to population control since the diversity of species helps to keep undesirable populations for agricultural production under control, reducing or eliminating the use of pesticides (chemical or organic). AFSs are important for the conservation of plant diversity and, consequently, of ecosystems, and also for food and medicinal purposes, as opposed to the agriculture model that prioritizes large-scale monoculture.

Based on the research carried out, it is recommended that more agroforestry systems be reported and disseminated to highlight the importance of AFSs in maintaining biodiversity and promoting options for sustainable crops in harmony with natural ecosystems. Other relevant information, including scientific nomenclature, richness and abundance of AFSs, size and density of the area and whether spontaneous plants have been incorporated into the agroecosystem, should also be published.

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