Research, Society and Development, v. 10, n. 7, e17810716420, 2021
(CC BY 4.0) | ISSN 2525-3409 | DOI: http://dx.doi.org/10.33448/rsd-v10i7.16420

Analysis of the botanical biodiversity of orchards in the Pampa Biome

Análise da biodiversidade vegetal de pomares no Bioma Pampa

Análisis de la biodiversidad vegetal en huertos en la Pampa

Received: 05/23/2021 | Reviewed: 05/30/2021 | Accept: 06/03/2021 | Published: 06/18/2021

Adriana Carla Dias Trevisan
ORCID: https://orcid.org/0000-0002-5192-6431
Echoes of the Pampa Research Group
State University of Rio Grande do Sul, Brazil
E-mail: adriana-trevisan@uergs.edu.br
Bianca Cristiele da Silva
ORCID: https://orcid.org/0000-0001-8495-8301
Echoes of the Pampa Research Group
State University of Rio Grande do Sul, Brazil
E-mail: biancacristiele@gmail.com
Lui Muniz Schmitt
ORCID: https://orcid.org/0000-0001-5792-2688
Silvopastoral Systems Ecological Restoration Research Group
Federal University of Santa Catarina, Brazil
E-mail: luimsbr@hotmail.com
Vagner Lopes da Silva
ORCID: https://orcid.org/0000-0003-3359-0935
University of Republic of Uruguay, Uruguay
E-mail: vagner@fagro.edu.uy
Abdon L. Schmitt-Filho
ORCID: https://orcid.org/0000-0002-3553-7727
Silvopastoral System Ecological Restoration Research Group
Federal University of Santa Catarina, Brazil
E-mail: abdonfilho@hotmail.com

Abstract
Homegarden agroforestry is strategic alternatives, guaranteeing family income, food security, and the possibility of increasing diversity, stability, and sustainability of the productive system. However, in order to design and implement these systems, it is important to take into account regional natural diversity and to understand the ecological dynamics of its plant populations. The present study carried out in southern Brazil aimed to survey floristic data and characterizes three existing orchards (Q1, Q2 e Q3), to design and subsequently implement an agroforestry homegarden model for the Pampa Biome. A survey of floristic and dendrometric data of the different existing plant strata was carried out. For the arboreous strata, we measured tree height and diameter at soil height, and for the shrub and herbaceous strata, we collected data on richness and abundance from the local biodiversity. Frequency, density, and diversity analyses were performed using the Shannon and Pielou equitability indexes. A workshop was organized with the farmers aiming the design an agroforestry homegarden model for the Pampa Biome. The analyzed plots showed similar conditions of soil, relief, and climate, although between them, there were differences in spacing and management practices. With regards to the management, Q1 proved to be abandoned, whereas Q2 and Q3 showed signs of ongoing management. In the Shannon and Pielou Equitability indices, Q2 had the highest numbers, and Q1, the lowest values. As for frequency and density, the Sida genus stood out within all plots. During the participatory design of the new agroforestry homegardens, native species were chosen mainly to produce fruits for self-consumption.
Keywords: Agroecology; Diversity; Agroforestry homegarden; Agroforestry system; AFS; Family farm.

Resumo
Os quintais agroflorestais são uma alternativa estratégica garantindo renda à família, segurança alimentar, além da possibilidade de aumento de diversidade, estabilidade e sustentabilidade do sistema produtivo. Para implantação desses sistemas é importante considerar e conhecer a diversidade natural regional e entender as dinâmicas ecológicas das suas populações vegetais. Assim, o presente estudo foi realizado no sul do Brasil a partir do levantamento de dados florísticos e caracterização de 3 pomares (Q1, Q2 e Q3) existentes, visando o redesenho e posterior implantação de um sistema agroflorestal no Bioma Pampa. Realizou-se levantamento de dados florísticos e dendométricos dos diferentes estratos vegetais existentes. Para o estrato arbóreo foi realizado um censo das variáveis altura (H) e diâmetro da altura do solo (DAS) e para os estratos arbustivos e herbáceos uma amostragem para coleta de dados de riqueza e abundância da biodiversidade. Foi realizada a análise de frequência, densidade e de diversidade a partir dos

índices de Shannon e de equitabilidade de Pielou. Foi elaborado uma oficina com as agricultoras e elaborado um redesenho de seus quintais agroflorestais. Os quintais analisados apresentaram condições semelhantes de solo, relevo, clima, contudo registra-se diferenças no espaçamento e práticas de manejo. Quanto ao manejo, Q1 revelou-se abandonado, já Q2 e Q3 apresentou indícios de manejos constantes. Nos índices de Shannon e Equitabilidade de Pielou, Q2 apresentou maiores números e Q1TA e Q1TB, os menores números. Quanto à frequência e densidade, o gênero Sida se destacou nos 3 quintais. Nos desenhos dos quintais agroflorestais foram selecionadas espécies nativas, especialmente para autoconsumo nos novos quintais agroflorestais.
Palavras-chave: Agroecologia; Diversidade; Sistema agroflorestal; Quintais agroflorestais; SAF; Agricultura familiar.

Resumen
Los huertos agroforestales son alternativas estratégicas que garantizan el ingreso familiar, la seguridad alimentaria y la posibilidad de incrementar la diversidad, estabilidad y sustentabilidad del sistema productivo. Para implantar estos sistemas, es importante tener en cuenta la diversidad natural regional y entender las dinámicas ecológicas de sus poblaciones de plantas. Así, el presente estudio, se ha realizado en el sur de Brasil, a partir del levantamiento de datos florísticos y caracterización de 3 huertos existentes (Q1, Q2 y Q3), con el fin de rediseñar y posteriormente la implantación de un sistema agroforestal en el Bioma Pampa. Se evaluaron datos florísticos y dendrométricos de los diferentes estratos vegetales existentes. Para el estrato arbóreo, se midió la altura y el diámetro de la altura desde la superficie, y para los estratos arbustivos y herbáceos, se ha realizado un muestreo de datos de sobre la riqueza y abundancia de la biodiversidad. Se analizaron la frecuencia, densidad y diversidad a partir de los índices de Shannon y Pielou. Se organizó un taller con los agricultores con el objetivo de diseñar un modelo de huerto agroforestal. Los huertos analizados presentaron condiciones similares de suelo, relieve y clima, aunque entre ellos hubo diferencias en el espaciamiento y prácticas de manejo. En cuanto a la gestión, Q1 resultó abandonado, mientras que Q2 y Q3 mostraron señales de una gestión continua. En los índices de Shannon y Pielou, Q2 tuvo los números más altos y Q1TA e Q1TB los valores más bajos. En cuanto a frecuencia y densidad, el género Sida se ha destacado en los 3 huertos. En los diseños de huertos familiares agroforestales se eligieron especies nativas, especialmente para el autoconsumo en los nuevos huertos agroforestales.
Palabras clave: Agroecología; Diversidad; Sistema agroforestal; Huerto agroforestal; SAF; Agricultura familiar.

1. Introduction

In landscapes under agricultural and livestock management, the increase in the quantity and quality of ecosystem services, such as food production, nutrient availability, carbon sequestration, water, and soil protection, are associated with increased biodiversity (Altieri, Funes-Monzote & Petersen, 2011; Gliessman et al., 2007; Loreau & De Mazancourt, 2013). Agroforestry systems are multifunctional biodiverse systems. Agroforestry homegardens are traditional agroforestry systems aimed at food production, these techniques have guaranteed nutritional and food security, and promoted income generation and sustainability in land use (Fernandes & Nair, 1986; Huai & Hamilton, 2009; Mbow et al., 2014; Kelafi, 2020). They are considered a subtype of agroforestry systems (AFS) with multiple purposes located close to residential units (Fernandes & Nair, 1986; Huai & Hamilton, 2009; Mbow et al., 2014; Kelafi, 2020). They also feature unique ecological and socio-cultural assemblages that provide a diversified management practice, promoting coevolution from an agroecological perspective (Torquebiau, 1992; Kelafi, 2020).

In different Brazilian biomes, a high diversity of agroforestry systems and homegarden agroforestry have been studied (Florentino, Araújo & Albuquerque, 2002; Lunz, 2007; Miller & Nair, 2006; Muñiz-Miret et al., 1996; Sousa & Vieira, 2017). In the Pampa Biome, silvopastoral systems are the main AFSs, mainly with *Eucalyptus* sp. and *Pinus* sp. located in different pastures. Tree presence in pastures mainly results in several benefits for the components of the ecosystem: climate, soil, microorganisms, forage plants, and animals, in addition to contributing immensely to animal comfort (Borges, Calonego & Rosolem 2019; Deniz, 2019). However, there are quite a few challenges to establish AFSs in the Pampa, both in large areas and small properties. In short, we may point out the main difficulties being: the definition of tree and forage species, the training of farmers and ranchers, and the promotion of the innovation culture in the territory.

Therefore, the challenges are even more significant since the heterogeneous landscapes of the Pampa formed by floodplains, native countryside, shrub formations, riparian forests, and rock outcrops (Pillar & Lange 2015) have been fragmented and replaced by an agricultural matrix of low stability and diversity (Marchi et al., 2018). Unlike previous cattle transformation cycles, which tended towards new ecological stability standards, the current cycle involves an often-irreversible substitution. The effect of expanding agricultural frontiers is a significant cause of the destruction of natural resources and biodiversity in Brazilian biomes (Da Silveira Cunha et al., 2008; Mittermeier et al., 2005; Secretariat of the Convention on Biological Diversity, 2010). It is a high-disturbance regime that mischaracterizes and impoverishes the native pastures that sustains the main economic activity in the region, beef cattle.

In such landscape transformation in the Pampa territory, two scenarios are observed: one containing large properties of agribusinesses, and another with small properties of family farm agriculture and livestock. In large areas, extensive cattle ranching with low stocking rates, high environmental impact soybean farms, and forestry draw a large portion of the Pampa Biome landscape. On the other hand, there is an ongoing and pronounced extension from the agribusiness models in small and family properties, mainly related to the soybean. The effects of soy expansion are visible both in the drastic reduction of local biodiversity and environment contamination, which causes reduction of food security leading to the process of deterritorialization (Altieri, Funes-Monzote & Petersen, 2011; Godoy & Mello, 2017) of the gaucho culture. In this sense, the social and ecological coevolution between Pampa and the Rio Grande do Sul society is broken, once the biodiverse native pasture is transformed into soybeans and the extensive cattle-producing ranch into a cereal farm.

According to IBGE (2017), Santana do Livramento is the second-largest municipality in the extension of Rio Grande do Sul state. It has 694 thousand hectares, with 97% of this area occupied by 2962 agricultural establishments, and 81% of these establishments are family farms (IBGE, 2017). From the territorial extension perspective, 4% of the municipality's area is occupied by small family farmers, with establishments between 20 and 50 ha in agrarian reform settlements (Monteblanco et al., 2019). The same authors point out that family farming and livestock are centered on settlements since they have the largest area and number of settlers in the state. There are 31 settlements, with 926 families, totaling an area of 28,087.74 hectares (MDA, 2015). In the family farm environment, soy and livestock are the main production. However, the constant droughts and extreme heat waves have led small farmers and ranchers to increase indebtedness with banks. Along with this reality, when observing the family production units, it is observed frequently the existence of orchards next to their homes. Despite being poorly managed, these orchards represent both a portion of a nutritional security strategy and a financial backup. In this sense, it is understood that these orchards are treated as “safety nets” due to their potential to accommodate more stable and diverse production systems (Reta, 2016). Thus, orchards and complex agroforestry homegardens emerge as an instrument to promote many benefits and mitigate the impacts caused by the unsustainable management of agricultural production methods (De Freitas et al. 2018). Thus, this study's objective is to characterize the floristic diversity of existing orchards aiming redesign and subsequent implement an agroforestry homegarden model for the Pampa Biome.

2. Methodology

2.1 Characterization of the orchards

This study was carried out in three different locations: at the UERGS Rural Campus (CRU) and two properties at the União Rodeiense Settlement, located next to the CRU, municipality of Santana do Livramento, Rio Grande do Sul, Brazil. The criteria for selecting the areas were the existence of an orchard for at least ten years. In the CRU, an old persimmon orchard was selected as well as two properties of family farmers with diversified orchards, all of them resembling homegarden agroforestry. Thus, the 03 study areas were: (a) persimmon, called orchard 1 (Q1), (b) orchard on property 2 (Q2), and (c) orchard of property 3 (Q3).

The Q1 is located at the coordinates 30º52 '34.03 "S and 55º25' 55.40" O, Q2 at 30º51 '48.10 "S and 55º26' 06.64" O, and Q3 is located at 30º51 '46.19 "S and 55º26' 01" O. The region in which the orchards are located has a smooth undulating relief, ultisol soil, with predominantly subtropical climate, with well-defined seasons, average temperatures of 18.5ºC and an annual rainfall of 1,300 mm (SPGG-RS 2018).

2.2 Floristic and dendrometric data

The evaluation of the orchards' floristic and dendrometric data was carried after the mapping of experimental plots. The liner transects associated with the plot method was used for the floristic survey (Artigas & Del Olmo, 2013). Random transects of 5 m x 25 m were used to survey abundance in the shrub and herbaceous strata. Floristic data collections were carried out in June and July 2019. The differentiation between herbaceous and shrub species was based on the herbaceous or woody consistency of the aerial branches (Waechter, 2002). In Q1, there was a stratification of the area due to the difference in development, resulting in 2 transects (Q1TA and Q1TB), and in Q2 and Q3, one transects was delimited in each orchard. In the transects, all individuals from the shrub stratum with DSH ≥ 5cm were identified and counted. Those that were not taxonomically identified in the field were collected in the reproductive phase, if possible, or vegetative phase for identification. For the herbaceous layer, a wooden template was used for the location of 5 random samples of 1 m x 1 m per transect. The transects and samples within the transects were located using a @Garmin ETrex GPS and marked with a measuring tape and a wooden mold. For the tree strata, with the help of farmers, a census was carried out with botanical identification of all individuals from the 03 orchards. In addition, for the tree strata, the following dendrometric variables was carried out: height (H) and circumference at soil height (CSH), with the aid of a measuring tape Feeling® brand. CSH data were transformed to the diameter at soil height (DSH) according to the following formula: DSH = CSH / π.

After data collection, according to Bolfe & Batistella (2011); Santos, Miranda & Tourinho (2004), a structural analysis of the shrub and herbaceous strata in each orchard was carried out, succeeded by the following phytosociological parameters: relative frequency (RF) and relative density (RD). The evaluation of the diversity parameters was estimated by means of the Shannon-Wiever (1949) (S'), equitability of Pielou (1969) (J') and to evaluate the beta diversity with the Jaccard coefficient and the Morisita index were calculated (Krebs, 1989) through the @Past program.

2.3 The design of agroforestry homegardens

During data collection, interaction with farmers was promoted, seeking to understand the history and management of each orchard, as well as the identification of species of future interest. The construction of activities took place from the methodological approach of social cartography (Barragán-León, 2019). As a result, a list of desired species to the farmers was designed, followed by the purchase of seedlings from the Forest Research Center of the State of Rio Grande do Sul's Agriculture and Supply Department. The participatory design involving students was then elaborated along with farmers and, subsequently, the agroforestry techniques were implemented.

3. Results and Discussion

3.1 Characterization of backyards

The characterization of the three studied orchards can be seen in Table 1.

Table 1. Characterization of the research plots. (AM = sample; A = area; ARG = ultisol; N = total number of species in the 3 strata; NA = percentage of native Brazilian species found in all plant strata; ESP = line and line spacing of arboreal individuals; PD = trimming; ROÇ = Mowing; CQ = Chemical control; NA = stealthy presence of animals).

Characterization			Diversity		Management				
AM	**A (ha)**	**Soil**	**N**	**NA (%)**	**ESP (m)**	**PD**	**ROÇ**	**CQ**	**AN**
Q1	0,25	ARG	25	84	6x6	No	No	No	Yes
Q2	0,15	ARG	33	45,5	3,5x1,5	Yes	Yes	Yes	No
Q3	0,1	ARG	24	75	4x4	Yes	Yes	Yes	No

Source: Authors (2020).

Orchard Q1 has a history of abandonment for 20 years and had 37 individuals of a single species, *Diospyros* sp., the persimmon tree. Planting was carried out by the former Fundação Estadual de Pesquisa Agropecuária (FEPAGRO) without varietal identification of the used species. Among the 37 found individuals, 17 (46%) were infested by *Struthanthus flexicaulis*, a hemiparasitic-perennial species, which is fixed on the branches and trunks of the host plant and thrives and occupies almost the entire canopy (Leal, Bujokas & Biondi 2006; Mourão et al., 2006). In this scenario, Q1 had 14 individuals severely affected by this parasitic plant, and three were totally infested. Also, on the surroundings of the persimmon tree, we found a curtain of cypress trees (*Cupressus sempervirens*) with a frontal spacing of 7 m and lateral spacing of 15 m in a southeast direction.

Orchards Q2 and Q3 were highly biodiverse. Q2 had 70 tree individuals belonging to 20 different species: *Psidium cattleianum*, *Psidium guajava*, *Pyrus L*, *Myrcianthes pungens*, *Citrus reticulata*, *Hovenia dulcis*, *Melia azedarach*, *Annona montana*, *Musa* sp., *Prunus* sp., *Prunus persica*, *Cydonia oblonga*, *Ficus carica*, *Diospyros* sp., *Eugenia pyriformis*, *Cinnamomum* sp., *Eugenia involucrata*, *Olea europaea*, *Ceiba* sp., *Citrus sinensis*. Q3 had 38 tree individuals belonging to 5 different species: *Campomanesia xanthocarpa*, *Annona montana*, *Eugenia uniflora*, *Psidium cattleianum*, *Citrus sinensis*.

3.2 Floristic and dendrometric data

The floristic richness and its abundances involving the herbaceous and shrub strata can be seen below in Table 2. Regarding the functional groups of the species, 88.8% of the floristic data were classified as pioneers of the natural succession process. These pioneers have the ecological function of colonization in the secondary succession process, enabling the emergence of other more demanding species (Silva et al., 2017). They are heliophiles species, with autochoric or anemochoric syndrome, being capable of establishing themselves in degraded soils and forming seed banks (Pereira, 2006). On the other hand, this succession is made up to 10% with zoochory syndrome. Therefore, according to Pereira (2006), they are pioneering attractors of fauna. By increasing the number of attractions or dispersers, it leads to an increase in local biodiversity. In view of the analysis of the current floristic composition, the highest abundance in the shrub stratum of the species *Sida rhombifolia* stands out in the three analyzed orchards. This species is considered an indicator of compacted, acidic soil with low fertility (Junqueira et al., 2013). When analyzing the two strata together (Table 2), *Eragostris plana*, a typical succession-activating pioneer exotic species with a high degree of invasion and seed bank formation (Ferreira, Medeiros & Favreto, 2008; Guido, Hoss & Pillar, 2019; Pagnussat & Bonetti, 2019) stands out in frequency in Q1TA and Q2. As seen in Table 2, in Q1TB, there are records of hygrophilous species, such as *Christella dentata*, *Cyclopermum leptophyllum*, and *Echinodorus grandiflorus*. This fact is the result of the methodological procedure that divided Q1 into two transects. This division happened due to the variation in slope and soil density, which resulted in different environmental conditions and, consequently, in different species from those found in Q1TA.

Table 2. Richness and density of species found in the orchards (SDisp = dispersion syndrome; AUT = autochory; ANE = anemochory; ZOO = zoochory).

Strata	Family	Scientific name	Sdisp*	Q1TA	Q1TB	Q2	Q3
				Relative density			
Shrub	Lamiaceae	*Mesosphaerum suaveolens*	AUT	6,02	2,94	**33,09**	1,85
	Asteraceae	*Baccharis crispa*	ANE	4,96	1,26	0	0
	Polygonaceae	*Polyginum persicaria*	AUT	1,53	1,26	0	0
	Rubiaceae	*Hexasepalum teres*	ANE	8,26	0	0	0
	Asteraceae	*Conyza canariensis*	ANE	0,35	0	0	2,22
	Apiaceae	*Eryngium horrindum*	ANE	1,30	0	0	0
	Fabaceae	*Desmodium tortuosum*	ZOO	20,78	0,84	0	0
	Asteraceae	*Vernonia sp.*	ANE	0	0	16,91	0
	Apiaceae	*Bidens pilosa*	ZOO	0	0	16,18	2,22
	Asteraceae	*Conyza bonariensis*	ANE	0	0	9,56	2,96
	Asteraceae	*Ambrosia sp.*	ANE	0	0	0	3,89
	Amaranthaceae	*Amaranthus airdus*	ANE	0	0	0	1,67
	Solanaceae	*Solanum americanum*	ZOO	0	0	0	3,15
	Malvaceae	*Sida rhombifolia*	AUT	**56,79**	**93,71**	24,26	**82,04**
Herbaceous	Poaceae	*Paspalum notatum*	ANE	17,14	0	0	0
	Poaceae	*Eragostris plana*	ANE	**47,62**	5,15	**42,58**	0
	Hypoxidaceae	*Hypoxis decumbens*	AUT	13,33	0	0	0
	Fabaceae	*Desmodium sp.*	ZOO	5,71	0	0	3,23
	Poaceae	*Axonoplus affinis*	AUT	1,90	5,68	17,42	4,61
	Apiaceae	*Cyclospermum leptophyllum*	AUT	5,71	2,84	7,10	**41,47**
	Plantaginaceae	*Plantago sp.*	ANE	8,57	0	0	0
	Cyperaceae	*Cyperus rotundus*	AUY	0	**27,71**	0	0
	Asteraceae	*Elephantopus mollis*	ANE	0	21,49	20,00	0
	Poaceae	*Axonoplus sp.*	AUT	0	3,37	0	0
	Caryophyllaceae	*Stellaria media*	ANE	0	9,59	0	5,53
	Poaceae	*Poa annua L.*	ANE	0	10,66	0	3,23
	Alismataceae	*Echinodorus grandiflorus*	ANE	0	8,88	0	0
	Oxilidaceae	*Oxalis sp.*	AUT	0	1,60	1,94	15,67
	Thelypteridaceae	*Christella dentata*	AUT	0	0,36	0	0
	Commelinaceae	*Commelina sp.*	AUT	0	2,66	6,45	0
	Poaceae	*Leersia hexandra*	ANE	0	0	3,87	9,68
	Poaceae	*Cenchus clandestinum*	ANE	0	0	0,65	0
	Asteraceae	*Taraxarum oxinales*	ANE	0	0	0	1,38
	Poaceae	*Lollium multiflorum*	ANE	0	0	0	9,22
	Cyperaceae	*Rhynchospora nervosa*	ANE	0	0	0	5,07
	Asteraceae	*Soliva pterosperma*	ANE	0	0	0	0,92

*Fontes et al., (2003), Freitas, (2012); Grigoletto, (2013); Maraschin-Silva, Scherer & Baptista, (2009); Peres, (2016); Silva et al. (2013).
Source: Authors (2020).

Table 3 shows the dendrometric data of the arboreous individuals in the plots described in the previous section.

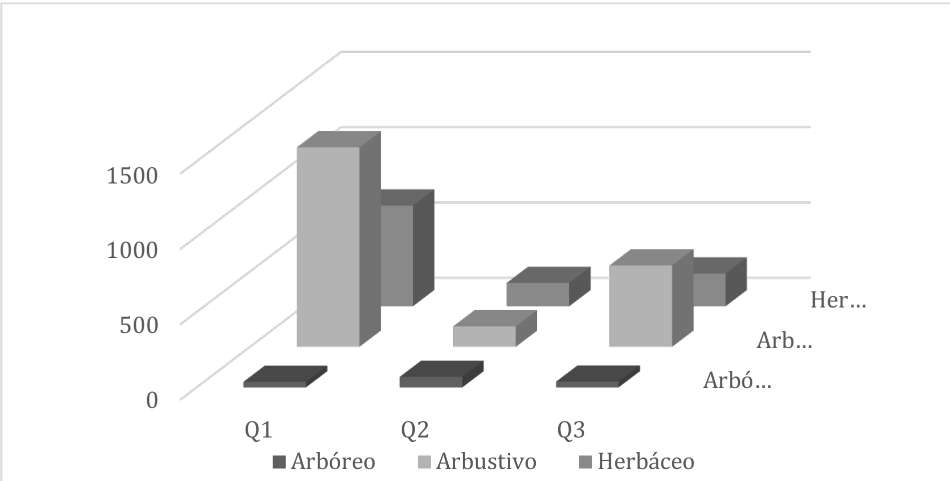
Table 3. Dendrometric data of arboreal individuals

	N	DSH (cm)					H (cm)				
		Avg.	**Min.**	**Max.**	**SD**	**CV (%)**	**Avg.**	**Min.**	**Max.**	**SD**	**CV (%)**
Q1	37	30,9	18,5	50,9	7,1	23,1	80,0	30,0	193,0	35,1	43,93
Q2	70	9,1	1,9	30,2	6,4	70,6	38,0	3,0	161,0	33,6	88,46
Q3	38	4,5	1,3	11,8	2,3	49,6	12,7	0,0	54,0	10,7	84,47

(N = number of arboreal individuals in the orchards; DSH = diameter at soil height; H = height; Avg. = Mean; Min. = Minimum; Max. = Maximum; SD = standard deviation; CV = coefficient of variation).
Source: Authors (2020).

In Figure 1 below, the vertical stratification of individuals is observed in the three studied orchards.

Figure 1. Vertical stratification in the orchards.



Source: Authors (2020).

Regarding the functional groups of the species, 88.8% of the floristic data were classified as pioneers of the natural succession process. These pioneers have the ecological function of colonization in the secondary succession process, enabling the emergence of other more demanding species (Silva et al., 2017). They are heliophiles species, with autochoric or anemochoric syndrome, being capable of establishing themselves in degraded soils and forming seed banks (Pereira, 2006). On the other hand, this succession is made up to 10% with zoochory syndrome. Therefore, according to Pereira (2006), they are pioneering attractors of fauna. By increasing the number of attractions or dispersers, it leads to an increase in local biodiversity. In view of the analysis of the current floristic composition, the highest abundance in the shrub stratum of the species *Sida rhombifolia* stands out in the three analyzed orchards. This species is considered an indicator of compacted, acidic soil with low fertility (Junqueira et al., 2013). When analyzing the two strata together (Table 2), *Eragostris plana*, a typical succession-activating pioneer exotic species with a high degree of invasion and seed bank formation (Ferreira, Medeiros & Favreto, 2008; Guido, Hoss & Pillar, 2019; Pagnussat & Bonetti, 2019) stands out in frequency in Q1TA and Q2. As seen in Table 2, in Q1TB, there are records of hygrophilous species, such as *Christella dentata*, *Cyclopermum leptophyllum*, and *Echinodorus grandiflorus*. This fact is the result of the methodological procedure that divided Q1 into two transects. This division happened due to the variation in slope and soil density, which resulted in different environmental conditions and, consequently, in different species from those found in Q1TA.

From the perspective of diversity, richness, and equitability between orchards, and within the vertical strata itself (Table 4), we found that there was no significant variation in the number of species. However, the number of individuals was different among the orchards in both strata. Comparing the yard with the highest number of individuals with the one with the lowest amount, in Q3, only 18.6% of the total herbaceous found in Q1TB was registered. In the shrub stratum, Q2 had 16% of the total number of individuals found in Q1TB. As for the Shannon (S') and Pielou (J') equability indices, it is noteworthy that Q1TB also stood out with the highest value for S 'and J' for the herbaceous strata, whereas in the shrub, although Q2 had the smallest number of individuals registered, it also had the highest value of S 'and J.'

Table 4. Analysis of the diversity of shrub and herbaceous strata in the orchards

	S		**N**		**S'**		**J'**	
Orchards	**AR**	**HE**	**AR**	**HE**	**AR**	**HE**	**AR**	**HE**
Q1TA	8	7	847	105	1,31	1,53	0,63	0,79
Q1TB	5	11	477	563	0,31	2,07	0,19	0,83
Q2	5	8	136	155	1,52	1,58	0,95	0,76
Q3	8	11	540	217	0,81	1,87	0,39	0,78

(S = wealth; N = number of individuals; S '= Shannon index; J' = Pielou index).
Source: Authors (2020).

Table 5 presents the analysis of the beta diversity indexes, Jaccard and Morisita-Horn, in which the highest Jaccard value identified between Q2 and Q1TB in the two studied strata describes that there is a similarity of 43% of the species between the respective plots. When observing the diversity between similar environments it is important to take into account not only the presence and absence but also the proportional abundance of the species. The respective plots Q2 with Q1 (TA and TB) registered 56% similarity from Morisita-Horn. In the same way in the shrub stratum, Jaccard points out the similarity of 62% of the species between the two transects in Q1 (TA and TB) whereas Q2 and Q3 were more similar (44%) to each other. When observed, the dominance of species in Morisita-Horn Q3 and Q1TB presented 90% similarity of the botanical species found, and this 73% with Q1TA that with Q1TB obtained 83% similarity.

Table 5. Analysis of similarity of shrub and herbaceous extracts in the orchards (below 1 Jaccard and above Morisita-Horn).

Stratum	**Orchards**	**Q1TA**	**Q1TB**	**Q2**	**Q3**
Herbaceous	**Q1TA**	1	0,25	0,56	0,18
	Q1TB	0,19	1	0,56	0,31
	Q2	0,25	0,43	1	0,32
	Q3	0,20	0,28	0,26	1
Shrub	**Q1TA**	1	0,83	0,48	0,73
	Q1TB	0,62	1	0,47	0,90
	Q2	0,18	0,25	1	0,55
	Q3	0,23	0,18	0,44	1

Source: Authors (2020).

In this study, the floristic diversity of the natural regeneration of the herbaceous and shrub strata with different management practices was evaluated. Q1 can be seen on the one hand as a control from the perspective of the use of chemical inputs, and on the other as a place for assessing the impact of stealthy horse visits. The similarity between the orchards was

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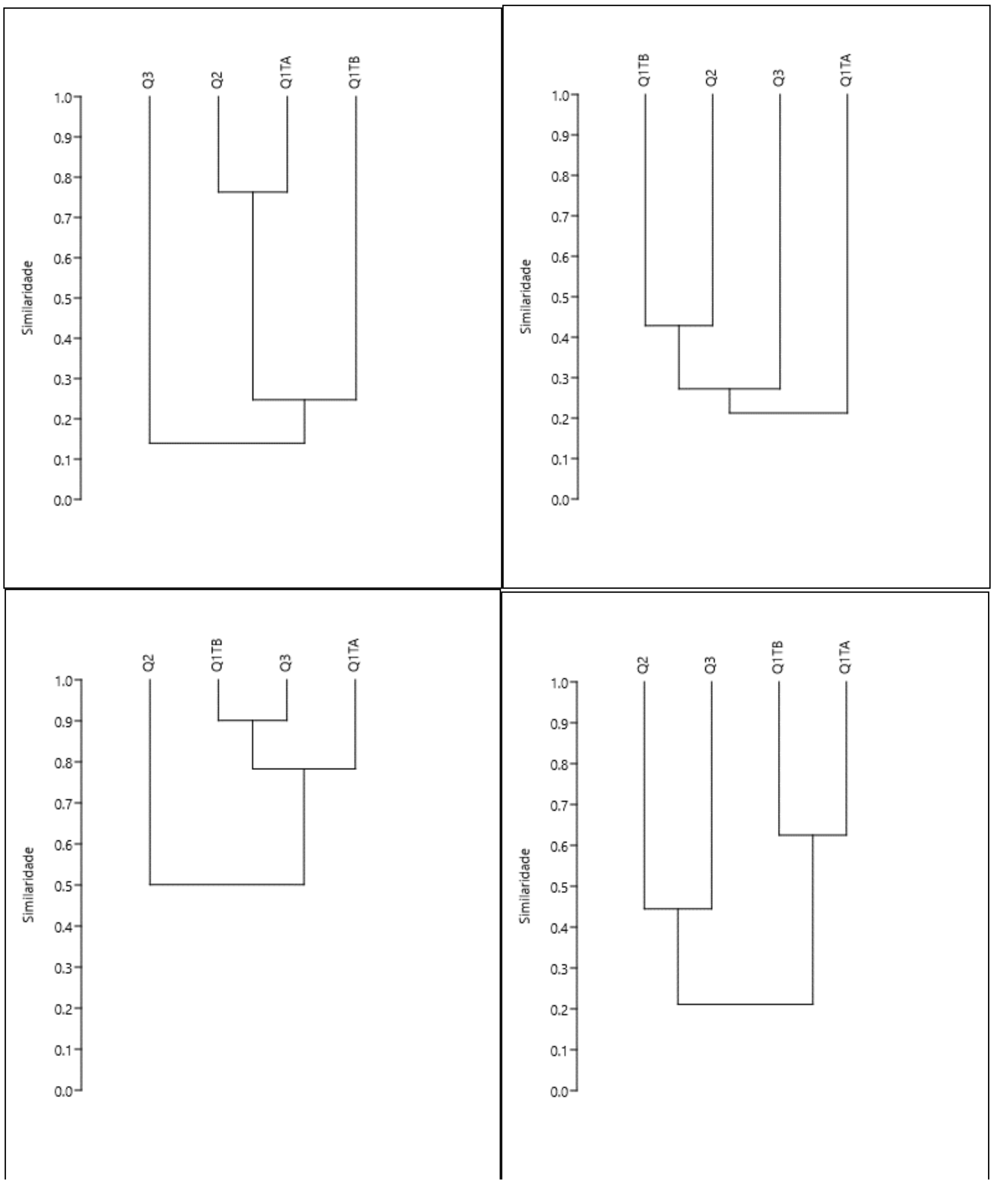
built from the Jaccard-Morisita-Horn index, and the graphical synthesis of the data can be seen in Figure 2. The cluster analysis in Figure 2 shows that there is a similar floristic set between the plots. However, when analyzing the abundances, the results indicate different management practices observed in the fieldwork. It is noteworthy that some variables are indicated as responsible for the registered floristic dynamics, namely: use of herbicides, pruning, weeding, presence of animals, and spacing in the orchard of tree species. Thus, Q1TA and Q2 had 47.5 and 42.6%, respectively, of the dominance of *Eragostris plana*, an exotic herbaceous species with a high degree of invasion in the Pampa, which generated floristic similarity. In Q1TB, it is registered that 49.2% are represented by *Cyperus rotundus* and *Elephantopus mollis*, species of mesophilic environments, and in Q3 *Cyclopermim leptophyllum* with 42%, which made both yards different from one another. From the perspective of the evaluation of the shrub environment, *Sida rhombifolia* is present in Q1TA, Q1TB, and Q3 with the following respective values, 57%, 93% and 82%, indicating that the similarities in abundances were apparent in Q1 (TA and TB) with Q3. Demonstrating that the spacing in Q2 may have caused the distance from other plots.

Figure 2. Similarity Index: A = Herbaceous Morisita; B = Herbaceous Jaccard; C = Shrub Morisite; D = Shrub Jaccard.



Source: Authors (2020).

3.3 Design and implementation of agroforestry homegardens

The redesign of the orchards for agroforestry homegardens was prepared together with the farmers during the project activities. For the design, all gathered information from existing arboreous individuals was taken into account. The species diversity and abundance used in each orchard are described in Table 4.

Table 4. Number of individuals, species used in the crops and their functions in orchards (Pol = pollinators; I = insects (bees, dipterans, lepidopterans); SDisp = dispersion syndrome; AU = autochory; ZO = zoochory; AN = anemochory; AD = fertilizer; FR = fruitful; OR = ornamental).

Family	Common name	Scientific name	Q1	Q2	Q3	Pol.	SDisp	Function in AFS
Fabaceae	Angico	*Parapiptadenia rigida*	2	1	-	I	AU	AD
Myrtaceae	Araçá vermelho	*Psidium cattleyanum*	6	-	2	I	ZO	FR
Myrtaceae	Cerejeira do mato	*Eugenia involucrata*	9	-	-	I	ZO	FR
Fabaceae	Corticeira do banhado	*Erythrina cristagalli*	8	7	-	I	AU	AD/OR
Myrtaceae	Guabiju	*Myrcianthes pungens*	5	10	9	I	*ZO*	FR
Myrtaceae	Pitanga	*Eugenia uniflora*	8	14	-	I	*ZO*	FR
Lamiaceae	Tarumã amarelo	*Vitex megapotamica*	-	3	2	I	ZO	OR
Myartaceae	Uvaia	*Eugenia pyriformis*	6	10	3	I	ZO	FR
Fabaceae	Timbaúva	*Enterolobium conrostisiliquum*	4	-	-	I	ZO	AD
Boraginaceae	Guajuvira	*Cordia americana*	-	17	10	I	AN	FR
Total			**48**	**62**	**26**			

Source: Authors (2020).

Concerning the use of native species in the studied orchards, it should be noted that the species preferred by farmers were: *Eugenia uniflora*, *Myrcianthes pungens*, and *Psidium cattleyanum*. The knowledge and selection of native species for production represents an emerging asset of local ethno knowledge attributed to the local heritage of the Pampa Biome. This is mainly regarding botanical identification, functionalities, uses, and management practices, thus justifying their insertion in these orchards (Capora, 2007; Gomes et al., 2015; Pinto, 2012) standing out as a source of knowledge to be used in the new paradigm of sustainable, productive systems (Okigbo, 1990; Camargo, 2014; Rocha, Boscolo & Fernandes, 2015).

4. Conclusion

These results allow us to point out reflections and guidelines regarding the dynamics of the floristic community in family farms orchards. Especially useful to monitor the role of botanical biodiversity in implementing agroforestry homegardens and perceptions related to the use of native species. From the farmers' point of view, it was possible to register the interest in the knowledge and cultivation of native fruit species from the Pampa Biome. It is also noteworthy that there is a prioritization of self-consumption due to the difficulties with establishing productive arrangements that make commercialization possible.

The diversity and distribution of species are influenced by management actions such as spacing when planting in these orchards, as well as daily practices that impose dynamics of constant disturbances, such as clearings, chemical control, and the presence of animals. As a result of these actions, the studied plots' structural and floristic analysis indicates that the most abundant species were: *Eragrostis plana* and *Sida rhombofolia*. These species are indicators of a negative selection process by grazing and soil compaction. Despite different pressures in the studied areas, the floristic dominance and similarity identified between particular plots indicate an equal similarity concerning the management practices used over time.

Based on the analysis of the characterization and floristic dynamics existing in the studied orchards, it is possible to define management strategies based on the shading differences, as well as using the same mechanism in the planning of economically interesting species to their respective photosynthetic mechanisms. From the implementation of the farmers' drawings of agroforestry homegardens and the use of an electric fence to contain the horses, an increase in the planned diversity was promoted. Over time, this will have a direct influence on the floristic dynamics of the shrub and herbaceous strata. Our results here represent an initial landmark on characterization of the ecological dynamics in three locations. These locations represent the cultural, environmental, and ecological conditions of most orchards in the properties of family farmers in the Pampa Biome.

This study lead to the following research strategic areas for the Pampa's AFSs, synergies and trade-offs processes between different native species, and delimitation of leaf functional attributes as ecological predictors to guide AFSs management strategies in the Pampa Biome.

Acknowledgments

We thank FAPERGS (Number 03/2019 - Institutional Program for Scientific Initiation and Technological Initiation and Innovation - PROBIC / PROBITI) and the Initiation to Research Scholarship Program (PROBIP / UERGS 2019, PROBIP Number 28/2018).

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