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SURVEY OF WEED INFESTATION OF THREE LEVELS OF PASTURE DEGRADATION IN THE MUNICIPALITY OF CAHOEIRAS DE MACACU, STATE OF RIO DE JANEIRO

Alexandre Magno Brighenti[1]
Guilherme Kangussú Donagemma[2]
Róberson Machado Pimentel[3]

ABSTRACT

Objective: The objective of this work was to register weed species in pasture areas at different levels of degradation, as a subsidy for weed control and the recovery of degraded pastures.

Theoretical framework: Well-managed pastures provide socio-environmental benefits, being important carbon sinks and providing food for livestock. Studies related to the registration of weed species in pastures are an important tool towards the recovery and renewal of degraded pasture areas.

Method: A survey of weed species was carried out in pasture areas in the municipality of Cachoeiras de Macacu, State of Rio de Janeiro, using the inventory square method, in order to indicate the ideal moment to apply control practices due to the main registered weed species.

Results and conclusions: Twenty-three weed species were registered and distributed in 11 botanical families. The families that most stood out in number of species were: Fabaceae, Poaceae and Asteraceae. The weeds with the highest degree of importance were in descending order: *Paspalum notatum*, *Eupatorium maximilianii*, *Imperata brasiliensis*, *Desmodium incanum* and *Sporobolus indicus*. The values obtained for number of weeds, density and abundance increased as degradation levels evolved. The weed density referring to the lowest level of degradation can be used as a parameter in decision-making about the most appropriate moment to carry out the control of weed species. Average density value equal to 6.0 plants m^{-2} indicates the appropriate moment for adopting weed control practices, based on the main registered species. The similarity indices among sampling areas were high, evidencing the homogeneity of species among the different levels of degradation.

Research implications: The results obtained can be used as benchmarks in relation to the ideal time when farmers or ranchers should apply effective practices of weed control, based on the main species found in pastures. Consequently, minimizing or even avoiding the progressive degradation of pastures.

Originality/value: In general, the control of weeds in pasture areas in Brazil is neglected or carried out without the use of technical-scientific criteria. Phytosociological surveys of weed infestation can be used as guides for decision-making on the ideal moment for the application of control methods based on the main incident species, and may also be used in the development and formulation of public policies.

Keywords: Biodiversity, Floristic Composition, Environmental Sustainability, Phytosociology, Tropical Forages.

[1] Embrapa Gado de Leite, Juiz de Fora, Minas Gerais, Brazil. E-mail: alexandre.brighenti@embrapa.br
Orcid: https://orcid.org/0000-0002-6579-7394
[2] Embrapa Solos, Rio de Janeiro, Rio de Janeiro, Brazil. E-mail: guilherme.donagemma@embrapa.br
Orcid: https://orcid.org/0000-0003-0535-4783
[3] Universidade Federal Fluminense (UFF), Cachoeiras de Macacu, Rio de Janeiro, Brazil.
E-mail: robersonmp@id.uff.br Orcid: https://orcid.org/0000-0003-3163-5204

LEVANTAMENTO DA INFESTAÇÃO POR PLANTAS DANINHAS EM TRÊS NÍVEIS DE DEGRADAÇÃO DE PASTAGENS NO MUNICÍPIO DE CAHOEIRAS DE MACACU, ESTADO DO RIO DE JANEIRO

RESUMO

Objetivo: O objetivo deste trabalho foi cadastrar as espécies daninhas em áreas de pastagens em diferentes níveis de degradação, como subsídio ao controle de plantas daninhas e à recuperação de pastagens degradadas.

Referencial teórico: Pastagens bem manejadas proporcionam benefícios socioambientais, sendo importantes sequestradoras de carbono e fornecimento de alimento para o gado. Estudos relacionados ao cadastramento de espécies daninhas em pastagens são considerados ferramentas importantes no sentido de recuperar e renovar áreas de pastagens degradadas.

Método: Foi realizado um levantamento das espécies daninhas em áreas de pastagens no município de Cachoeiras de Macacu, Estado do Rio de Janeiro, utilizando o método do quadrado inventário, a fim de indicar o momento ideal de aplicação de práticas de controle em função das principais espécies daninhas cadastradas.

Resultados e conclusões: Vinte e três espécies de plantas daninhas foram cadastradas e distribuidas em 11 famílias botânicas. As famílias que mais se destacaram em número de espécies foram: Fabaceae, Poaceae e Asteraceae. As plantas daninhas com maior grau de importância foram em ordem decrescente: *Paspalum notatum*, *Eupatorium maximilianii*, *Imperata brasiliensis*, *Desmodium incanum* e *Sporobolus indicus*. Os valores obtidos para número de plantas daninhas, densidade e abundância aumentaram à medida em que evoluíram os níveis de degradação. A densidade de plantas daninhas referente ao menor nível de degradação pode ser utilizada como parâmetro na tomada de decisão sobre o momento mais apropriado para realização do controle das espécies infestantes. O valor médio de densidade de 6,0 plantas m^{-2} indica o momento apropriado para adoção de práticas de controle de plantas daninhas, baseadas nas principais espécies cadastradas. Os índices de similaridade entre as áreas amostradas foram altos, evidenciando a homogeneidade de espécies entre os diferentes níveis de degradação.

Implicações da pesquisa: Os resultados servem como balizadores em relação ao momento ideal em que agricultores ou pecuaristas deveriam aplicar práticas eficazes de combate às plantas daninhas, baseadas nas principais espécies encontradas nas pastagens. Consequentemente, minimizando ou, até mesmo, evitando a degradação progressiva dos pastos.

Originalidade/valor: De modo geral, o controle de espécies daninhas em áreas de pastagens no Brasil é negligenciado ou realizado sem o uso de critérios técnico-científicos. Os levantamentos fitossociológicos da infestação por plantas daninhas servem como norteadores para tomadas de decisão sobre o momento ideal das aplicações de métodos de controle baseados nas principais espécies incidentes, podendo ainda ser empregados no desenvolvimento e formulações de políticas publicas.

Palavras-chave: Biodiversidade, Composição Florística, Sustentabilidade Ambiental, Fitossociologia, Forrageiras Tropicais.

1 INTRODUCTION

The municipality of Cachoeiras de Macacu is part of the metropolitan region of the state of Rio de Janeiro. Its economy is based on agriculture, mainly the cultivation of coconut, guava, yam, cassava and corn, as well as cattle ranching (Pedreira et al., 2011). The region has about 23,600 ha of pasture areas of which 2,500 hectares with signs of degradation (LAPIG, 2018).

Agricultural activity without proper management, with riverside crops, on the slopes and tops of hills, besides intensive use of fertilizers and pesticides is considered as a complicating factor in the conservation of the natural resources of this place (Pedreira et al., 2011).

Another aggravating factor is the presence of areas unsuitable for agroforestry use, with extensive livestock farming and burning in pastures, contributing to its degradation and compromising the productive sustainability of the soils (Pedreira et al., 2011). As a result, fodder production is temporarily reduced or rendered impossible and the degradation process progresses over time, tending to reach high levels if no recovery measures were applied.

Very few studies have been carried out in an attempt to separate the levels of degradation of these pastures using soil quality indicators in field conditions (Machado & Machado, 2021).

The identification and classification of levels of degradation is the starting point for understanding the processes and causes that triggered the quantitative and/or qualitative losses of the pastures and also to direct effective techniques of recovery or renewal of the pasture (Machado & Machado, 2021).

Normally, it is more difficult, expensive and time-consuming the pasture recovery when how much advanced is the level of degradation (Dias Filho, 2017).

In these areas, an excessive increase is observed in the percentage of weeds whose intensity of infestation increases as the degradation evolves.

However, one of the main obstacles faced by cattle ranchers considering the weed management is the lack of knowledge that can guide them in relation to the most suitable method and also the ideal moment of control. Parameters that assist in making decisions about the propitious moment of control, as well as the choice of method, based on the main weeds, are crucial aspects that must be considered in the recovery of degraded pastures.

In this context, one of the techniques that can contribute to obtain accurate choices in the elimination of weed populations is based on the phytosociological surveys of the weed communities (Braun-Blanquet, 1950). This method is based on the identification, counting and classification of plants according to their respective degrees of importance, obtaining data of frequency, density, abundance, relative importance index and coefficients of similarity of the species occurring in the determined locations (Erasmo et al., 2004).

Based on the knowledge of the qualitative and quantitative characteristics of the plant community, it is possible to draw up plans for controlling weeds (Kuva et al., 2007; Oliveira e Freitas, 2008), capable of assisting in the recovery of degraded areas (Tuffi Santos et al., 2004).

The objective of this work was to register the weeds in pasture areas at different levels of degradation, as a subsidy to weed control and recovery of degraded pasture, in the municipality of Cachoeiras de Macacu, Rio de Janeiro State.

2 METHODS

The phytosociological registration of weed species was carried out in the period from January 03, 2023 to January 05, 2023, in the municipality of Cachoeiras de Macacu, State of Rio de Janeiro, in pasture areas of the Farm School Cachoeiras de Macacu of the Fluminense Federal University (UFF) ($22^0$31`15.76"latitude south and $42^0$42`28.74"longitude West).The assessed pastures were previously composed of stretches of Atlantic Rain Forest that were replaced by pastures of *Urochloa humidicola*, approximately 40 years old.

Each level of degradation (N_1 = low degradation, N_2 = moderate degradation and N_3= strong degradation) was assessed visually according to the methodology of Spain and Gualdrón (1991), with four repetitions. The sampling areas were located in the middle third of the slopes according to the regional landscape, in Yellow Red Latossolo of clay texture (Santos et al., 2018). The areas used in the study were selected visually using *Google Earth Pro*, to draw the map with the geographical coordinates of the central point (Table 1, Figure 1). Field expeditions have been carried out to locate geo-referenced points *in situ* with the help of the *GPS eTREX*

10 Garmin. Soil samples were taken at depths of 0-10 cm and 10-20 cm and the results of the chemical analyzes were presented in Table 2.

The climate of the region is classified of Cwa (Koppen, 1948), typical of southeastern Brazil, characterized by dry winter and rainy summer (Alvares et al., 2013).

The method of the square inventory or census of plant populations was adopted for the weed registration (Braun-Blanquet, 1950), which is based on the use of a square of 1.0 x 1.0 m = 1m², placed at random inside the areas of pasture. Each level of degradation had four repetitions, with eight (8) samples of 1 m^2 per repetition, totaling 32 m^2.

The weeds were identified by species and counted. Subsequently, the frequency, relative frequency, density, relative density, abundance, relative abundance, relative importance index, and degree of similarity among different levels of degradation were obtained, as follows: frequency (F) = number of squares containing the species ÷ total number of squares obtained (total area), relative frequency (RF) = (species frequency ÷ total frequency of all species) x 100, density (D) = total number of plants per species ÷ total number of squares obtained (total area), relative density (RD) = (species density ÷ total density of all species) x 100, abundance (A) = total plants by species ÷ total number of squares containing the species, relative abundance (RA) = (abundance of the species ÷ total abundance of all species) x 100, relative importance index (RII) = relative frequency + relative density + relative abundance. The similarity index (SI) was calculated based on the method proposed by Sorensen (1972): (SI) = (2a / b +c) x 100, a = number of species common to two sites and b and c = total number of species existing in each locality. SI is expressed as a percentage, being 100% when all species are common to both areas and 0% when there are no species in common.

3 RESULTS AND DISCUSSION

The phytosociological registration of the weeds in the pasture areas of the municipality of Cachoeiras de Macacu showed the occurrence of 23 species, belonging to 11 botanical families (Table 3). Three families stood out in number of species, Fabaceae and Poaceae with five species and Asteraceae with four species. These results were similar to those obtained by Brandão et al. (1995). The authors led surveys of the weed flora in areas of pastures and grain crops, in Rio de Janeiro state. I were found that the families with the most significant numbers of species were Asteraceae with 75 species, Poaceae with 55 species, and Fabaceae with 21 species. Species of the family Asteraceae were confirmed as plants well adapted to soils under conditions of high acidity (Silva & Honoré, 2019), which can be proven by the low pH values obtained in the sampled areas, mainly at the lowest level of degradation (N_3) (Table 2).

Regarding the relative importance index, the main weeds found in the region were: *Paspalum notatum* with 11.8 plants m^{-2}; 0.2 of frequency; 60.1 of abundance and 69.4% of relative importance index; *Eupatorium maximilianii* with 8.2 plants m^{-2}; 0.4 of frequency; 19.8 of abundance and 46.9% of relative importance index; *Imperata brasiliensis* with 7.1 plants m^{-2}; 0.1 of frequency; 42.9 of abundance and 46.8% of relative importance index; *Desmodium incanum* with 3.2 plants m^{-2}; 0.3 of frequency; 9.0 of abundance and 26.2% of relative importance index and *Sporobolus indicus* with 1.3 plants m^{-2}; 0.3 of frequency; 4.5 of abundance and 16.1% of relative importance index (Table 4).

The predominance of particular species is partly related to its adaptability to the soil and climatic conditions of each region. This fact can be observed in relation to the establishment of *Paspalum notatum* and *Imperata brasiliensis* in areas of acidic soils (Kissmann & Groth, 1997; Araújo et al., 2011). These two species stood out in terms of incidence, mainly in the most advanced level of degradation (N_3) (Table 7), whose pH was the lowest recorded in the soil analyzes (Table 2).

Considering all sampled areas, *Paspalum notatum* stood out as the one with the highest relative importance index. This species is considered as very aggressive and widely spread in Brazil, infesting mainly pasture, wasteland and perennial crops (Lorenzi, 2000 *Paspalum notatum* plants quickly spread in *Megathyrsus maximus* and *Digitaria eriantha* pastures, replacing those forages (Kissmann & Groth, 1997). There is also another negative factor related to this species as cattle feed only when plants are

young (Lorenzi, 2000). Although there are many negative attributes to *Paspalum notatum*, this plant is very important from the point of soil management and conservation. The plants are able to cover exposed soils and, efficiently reducing erosion processes (Galvão, 2016).

Another plant that stood out was *Eupatorium maximilianii* as the level of degradation increased. The number of *Eupatorium maximilianii* plants and density increased considerably as the degradation level progressed from N_1 to N_3 (Tables 5, 6 and 7). This species is also highly adapted to the high acidity of soil conditions and is considered an indicative of low fertility and heavily degraded areas (Araújo et al., 2011; Santos et al., 2015). According to Pott et al. (2006), *Eupatorium maximilianii* has great competitive capacity, considerably reducing the carring capacity of pastures.

Other weeds that also stood out in sampled areas were *Imperata brasiliensis*, *Desmodium incanum* and *Sporobolus indicus*. These same species occurred in surveys carried out in the region of Petróplis, Rio de Janeiro state (Mautone et al., 1990). The authors verified the occurrence of *Imperata brasiliensis* in half of the places evaluated and *Desmodium incanum* and *Sporobolus indicus* in two of the sampled stations. There is a positive correlation between the presence of *Imperata brasiliensis* and low indices of exposed soil (Guillaumon & Fontes, 1992). The authors associated the fact with its low palatability. Additionally, this species is an indicative of high degree of soil degradation, and has also recovered rapidly in areas of repeated occurrence of forest fires (Vieira & Pessoa, 2001).

Desmodium incanum is also considered as a prominent weed in grassland, gardens, perennial crops and abandoned areas (Kissmann & Groth, 1999; Lorenzi, 2000). However, there is a reciprocal association between *Desmodium incanum* and rhizobacteria, with benefits for both (Silva, 2016). The plants are capable of carrying out symbiosis with the bacteria, speeding up the germination of rice seeds and, stimulating the growth of oats, wheat and corn, as well as solubilizing the phosphate in the soil. *Desmodium incanum* also has as a positive characteristic due to its acceptability by the animals, having considerable bromatological properties and good persistence under pasture (Boldrini, 1993). In addition, it adapts to the most varied types of soils, from those with low fertility and medium acidity, even very acidic soils (pH 4.5 or less) (Coradin et al., 2011).

Another weed species that has been spreading in a large part of Brazilian pastures is *Sporobolus indicus* (Dias Filho, 2015), considered a great problem to control in brasilian pastures (Caceres, 2021). It was registered its occurrence in the State of Rio de Janeiro, even, in hills such as Morro das Andorinhas, in the municipality of Niteroi (Machado et al., 2022). Plants of this species are rustic and endure long periods of drought; being tolerant to fire, mow and overgrazing. In addition, they develop satisfactorily in low fertility and compacted soils, producing large amounts of seeds, which can remain viable for up to 11 years (Royal Botanic Gardens Kew, 2015). Common causes of grassland degradation tend to stimulate the appearance and proliferation of this species (Dias Filho, 2017).

Compaction is a process of increasing soil density resulting from surface loads (Soane & Ouwerkerk, 1994). Density did not vary greatly among the different degradation levels (Table 2). However, there was considerable reduction in fertility with increasing levels of degradation. And, as fertility conditions got worse, there was an increase in the number of plants per m^{-2} of *Sporobolus indicus* from 0.5 plants m^{-2}, in N_1 to 1.7 plants m^{-2} in N_3 (Tables 5 and 7, respectively). This fact confirms the adaptation of this species to poor soils.

The preference for certain plants for animals should also be considered in grassland ecosystems, and it can bring about an unbalance of competition in pastures, favoring species with less or no acceptance by the animals, like *Imperata brasiliensis, Desmodium incanum* and *Sporobolus indicus*.

The total number of plants registered in the pastures with three levels of degradation was 3,564 (Table 4). There are approximately 2/3 of them belonging to the Poaceae family. Chemical control becames restricted in cases where there is a predominance of narrow-leaf weeds in pasture areas with forages from Poaceae family. This fact occurs due to the scarcity of herbicides capable in controlling narrow-leaf weeds, and, do not cause damages to the pastures of Poaceae Family, mainly *Urochloa* or *Megathyrsus* genus.

The weeds that stood out at the N_1 degradation level were: *Desmodium incanum* with 1.4 plants m^{-2}; 0.4 of frequency; 3.6 of abundance and 55.7% of relative importance index; *Eupatorium maximilianii* with 1.4 plants m^{-2}, 0.3 of frequency; 3.7 of abundance and 53.6% of relative importance index; *Pteridium* sp. with 0.6 plants m^{-2}; 0.1 of frequency; 4.4 of abundance and 33,3% of relative importance index; *Sporobolus indicus* with 0.5 plants m^{-2}; 0.3 of frequency; 1.7 of abundance and 29.0% of relative importance index); and *Solanum aculeatissimum* with 0.4 plants m^{-2}; 0.1 of frequency; 2.6 of abundance and 22.6% of relative importance index (Table 5).

The main weeds in N_2 degradation level were: *Imperata brasiliensis* with 9.2 plants m^{-2}; 0.2 of frequency; 36.8 of abundance and 64.4% of relative importance index; *Eupatorium maximilianii* with 5.6 plants m^{-2}; 0.5 of frequency; 9.4 of abundance and 42.0% of relative importance index; *Andropogon bicornis* with 4.2 plants m^{-2}; 0.2 of frequency; 16.8 of abundance and 33.2% of relative importance index; *Desmodium incanum* with 1.7 plants m^{-2}; 0.4 of frequency; 3.9 of abundance and 20.6% of relative importance index; and *Pterocaulon virgatum* with 1.3 plants m^{-2}; 0.5 of frequency; 2.6 of abundance and 20.0% of relative importance index (Table 6).

The main weeds in N_3 degradation level were: *Paspalum notatum* with 35.3 plants m^{-2}; 0.5 of frequency; 70.6 of abundance and 95.5% of relative importance index; *Eupatorium maximilianii* with 17.7 plants m^{-2}; 0.2 of frequency; 63.1 of abundance and 61.0% of relative importance index; *Imperata brasiliensis* with 12.2 plants m^{-2}; 0.2 of frequency; 49.0 of abundance and 46.5% of relative importance index; *Desmodium incanum* with 6.6 plants m^{-2}; 0.2 of frequency; 26.6 of abundance and 29.5% of relative importance index and *Sporobolus indicus* with 1.7 plants m^{-2}; 0.2 of frequency; 6.3 of abundance and 15.5% of relative importance index (Table 7).

The values obtained for number of plants, density and abundance increased as degradation levels evolved (Tables 5, 6 and 7).

The decision-making about the most adequate moment for adopting practices for controlling weeds in pasture is regarded as one of the difficuties faced by the cattle ranchers. One of the variables that could be used as an indicator parameter of the ideal moment of control would be the number of plants per m^{-2} (density), according to the minor level of degradation (Brighenti et al., 2023). As a result, progressive increases in degradation could be avoided that could culminate in higher levels such as the extremely strong degradation (Dias Filho, 2017). Based on this information, the approximate density of 6.0 plants m^{-2}, obtained at level N_1 (Table 5), would be the most appropriate parameter in relation to the ideal moment for the adoption of control practices. As the levels advance to N_2 and N_3, these values changed to 30 plants m^{-2} and 76 plants m^{-2} plants, respectively (Tables 6 and 7). Brighenti et al. (2023) found that, in degraded pastures located in the Middle Valley of Paraíba do Sul, state of Rio de Janeiro, Brazil, the density value referring to the minor level of degradation was 3.5 plants m^{-2}.

Another point to be considered is that it is not enough just to know the ideal moment for carrying out the control, but also what is the best method to use. Independently, of the weed control method adopted, this choice must always be aligned with the main species recorded in the phytosociological surveys.

According to Pott et al. (2006), the success of weed control begins with a floristic survey of weed species and knowledge about the biology of the predominant species.

Besides, it is not enough just to carry out an eficiente weed control in the processes of recovering degraded areas and areas infested with weeds. The correction of soil acidity, the use of fertilizers and the distribution of seeds of forages on uncovered soils are crucial and complementary practices in the recovery process (Oliveira et al., 2019). Another technique that has also been used in the renewal of pastures, with a significant reduction of infestation by weeds, is the implementation of agroforestry systems (Dias et al., 2018). The authors observed that, before the renewal of the pasture, 23 species of weeds were registered and, after the implantation of the agroforestry system, only three species were identified.

It becomes possible to obtain the percentage of common weed species among the areas from similarity index (SI). Percentages of SI are considered high over 50% (Felfili & Venturoli, 2000). In this case, all the similarity indices obtained were high, showing the homogeneity of species among the different levels of degradation (Table 8). The highest similarity index obtained was between the N_1/N2 levels (78%). And, the values were approximately equal in N_1/N_3 and N_2/N_3 (62%). High similarity indices may be related to the proximity among areas under similar environmental conditions. However, small differences among species contained in each area can be attributed, in part, to the anthropic actions and also to the differentiated management of the pasture, which can influence the germinative process and the establishment of the species (Souza et al., 2020).

The presence of a greater number of common species may facilitate the control process, since the correct choice of a single practice could attend the different areas and, consequently, reducing the costs of pasture recovery.

4 CONCLUSIONS

Twenty-three species of weeds were registered and distributed in 11 botanical families. The families that stood out in number of species were: Fabaceae, Poaceae and Asteraceae. The most important weeds were in descending order were: *Paspalum notatum*, *Eupatorium maximilianii*, *Imperata brasiliensis, Desmodium incanum* and *Sporobolus indicus.* The values obtained for weed numbers, density and abundance increased as degradation levels evolved. The density of weeds referring to the lowest level of degradation can be used as a parameter to a decision-making on the most appropriate moment for carrying out the control of weed species. The average density value equal to 6.0 plants m^{-2} indicates the appropriate moment for the adoption of weed control practices, based on the main registered species. The similarity index among areas was high, evidencing species homogeneity among different levels of degradation.

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ANNEXES

Table 1. Geographical coordinates of the pastures in each level of degradation in the municipality of Cachoeiras de Macacu, State of Rio de Janeiro.

Treatment	Repetition	Site	Latitude	Longitude
N_1	R_1	FECM	22º 31'16"S	42º 42'34"W
	R_2	FECM	22º 31'10"S	42°42'31"W
	R_3	SANTANA FARM	22º 31'48"S	42º 42'37"W
	R_4	SANTANA FARM	22º 32'04"S	42º 42’55"W
N_2	R_1	FECM	22º 31'26"S	42º 42'36"W
	R_2	FECM	22º 31'12"S	42°42'32"W
	R_3	FECM	22º 31'48"S	42º 42'19"W
	R_4	FARM DIZ - NELORES	22º 32'04"S	42º 43'23"W
N_3	R_1	LICO RANCH	22º 30'50"S	42º 41'54"W
	R_2	RICARDO FARM	22º 31'41"S	42°42'40"W
	R_3	LICO RANCH	22º 30'55"S	42º 41'57"W
	R_4	DANIEL RANCH	22º 30'52"S	42º 42'22"W

N_1: Low degradation; N_2: moderate degradation; N_3 strong. FECM: Farm School Cachoeiras de Macacu of the Fluminense Federal University (UFF).
Source: The authors (2023).

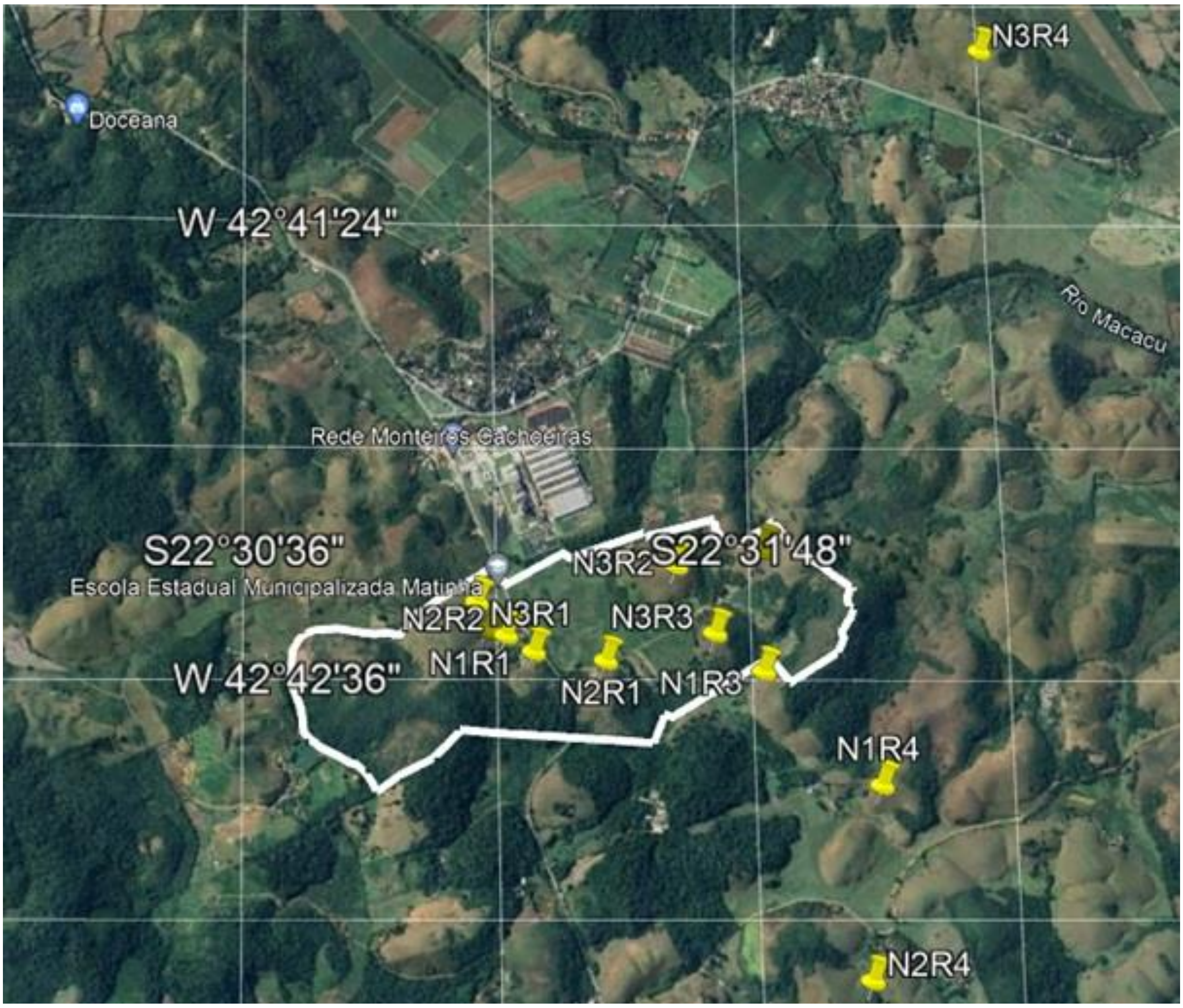

Figure 1. Panoramic view of the pasture areas at each level of degradation in the municipality of Cachoeiras de Macacu, State of Rio de Janeiro. (N_1: low degradation; N_2: moderate degradation; N_3: strong degradation. *Google Earth Pro*.
Source: The authors (2023).

Table 2: Soil attributes: active acidity **(**pH H_2O), V (base saturation), Al^{3+} aluminum saturation and soil density (DS) of the pasture areas at each level of degradation in the municipality of Cachoeiras de Macacu, State of Rio de Janeiro.

Degradation levels	Depth (cm)	pH H_2O	V (%)	Al^{3+} (cmolc kg^{-1})	Al^{3+} saturation (%)	DS (g cm^{-3})
	0-10	5.3	30.94	0.43	16.94	1.33
N_1	10-20	5.1	17.45	0.73	39.08	1.37
	0-10	5.1	21.61	0.83	34.80	1.32
N_2	10-20	5.0	15.86	1.08	50.14	1.35
	0-10	4.8	11.75	1.30	61.70	1.27
N_3	10-20	4.7	6.50	1.42	77.42	1.31

N_1: low degradation; N_2: moderate degradation; N_3: strong degradation.
Source: The authors (2023).

Table 3. Weeds distributed by family and species occurring in pasture areas with three (3) levels of degradation in the municipality of Cachoeiras de Macacu, State of Rio de Janeiro.

Family	Species (Scientific names)
Poaceae	*Imperata brasiliensis* *Andropogom bicornis* *Aristida longiseta* *Sporobolus indicus* *Paspalum notatum*
Cyperaceae	*Cyperus* sp.
Fabaceae	*Neonotonia wightii* *Desmodium incanum* *Mimosa pudica* *Stylosanthes viscosa* *Indigofera hirsuta*
Asteraceae	*Mikania cordifolia* *Pterocaulon virgatum* *Eupatorium maximilianii* *Vernonia westiniana*
Melastomataceae	*Miconia neourceolata* *Miconia albicans*
Apiaceae	*Centella asiatica*
Tiliaceae	*Triumfetta* sp.
Lamiaceae	*Hyptis suaveolens*
Rubiaceae	*Spermacoce* sp.
Solanaceae	*Solanum aculeatissimum*
Pteridaceae	*Pteridium* sp.

Source: The authors (2023).

Table 4. Number of squares in which the species was found (NQ), number of plants (NP), frequency (F), relative frequency (RF) (%), density (D) (plants m^{-2}), relative density (RD) (%), abundance (A), relative abundance (RA) (%) and relative importance index (RII) (%) of weeds occurring in pasture areas in the municipality of Cachoeiras de Macacu, State of Rio de Janeiro.

	N_1, N_2 and N_3								
Scientific name	**NQ**	**NP**	**F**	**RF**	**D**	**RD**	**A**	**RA**	**RII**
Sporobolus indicus	28	127	0.292	10.295	1.323	3.563	4.536	2.296	16.155
Eupatorium maximilianii	40	793	0.417	14.708	8.260	22.250	19.825	10.036	46.994
Cyperus sp.	19	25	0.198	6.986	0.260	0.701	1.316	0.666	8.354
Pterocaulon virgatum	31	84	0.323	11.398	0.875	2.357	2.710	1.372	15.127
Aristida longiseta	2	3	0.021	0.735	0.031	0.084	1.500	0.759	1.579
Imperata brasiliensis	16	687	0.167	5.883	7.156	19.276	42.938	21.737	46.896
Andropogon bicornis	11	142	0.115	4.045	1.479	3.984	12.909	6.535	14.564
Vernonia westiniana	10	18	0.104	3.677	0.188	0.505	1.800	0.911	5.093
Desmodium incanum	35	315	0.365	12.869	3.281	8.838	9,000	4.556	26.264
Neonotonia wightii	4	9	0.042	1.471	0.094	0.253	2.250	1.139	2.862
Hyptis suaveolens	2	2	0.021	0.735	0.021	0.056	1,000	0.506	1.298

Solanum aculeatissimum	6	25	0.063	2.206	0.260	0.701	4.167	2.109	5.017
Miconia neourceolata	11	40	0.115	4.045	0.417	1.122	3.636	1.841	7.008
Mimosa pudica	6	12	0.063	2.206	0.125	0.337	2,000	1.012	3.555
Spermacoce sp.	4	10	0.042	1.471	0.104	0.281	2.500	1.266	3.017
Pteridium sp.	7	64	0.073	2.574	0.667	1.796	9.143	4.628	8.998
Paspalum notatum	19	1,142	0.198	6.986	11.896	32.043	60.105	30.428	69.457
Centella asiatica	5	40	0.052	1.838	0.417	1.122	8,000	4.050	7.011
Triumfetta sp.	2	2	0.021	0.735	0.021	0.056	1,000	0.506	1.298
Indigofera hirsuta	5	5	0.052	1.838	0.052	0.140	1,000	0.506	2.485
Miconia albicans	5	6	0.052	1.838	0.063	0.168	1.200	0.607	2.614
Mikania cordifolia	3	12	0.031	1.103	0.125	0.337	4,000	2.025	3.465
Stylosanthes viscosa	1	1	0.010	0.368	0.010	0.028	1,000	0.506	0.902
	-	**3,564**	**2.83**	**100.00**	**37.12**	**100.00**	**197.53**	**100.00**	**300.00**

N_1: low degradation; N_2: moderate degradation; N_3 strong.
Source: The authors (2023).

Table 5. Number of squares in which the species was found (NQ), number of plants (NP), frequency (F), relative frequency (RF) (%), density (D) (plants m^{-2}), relative density (RD) (%), abundance (A), relative abundance (RA) (%) and relative importance index (RII) (%) of weeds occurring in pasture areas relative to the level of degradation N_1. Municipality of Cachoeiras de Macacu, State of Rio de Janeiro, 2023.

	N_1								
Scientific name	**NQ**	**NP**	**F**	**RF**	**D**	**RD**	**A**	**RA**	**RII**
Sporobolus indicus	10	17	0.313	14.286	0.531	9.189	1.700	5.529	29.004
Eupatorium maximilianii	12	45	0.375	17.143	1.406	24.324	3.750	12.196	53.663
Cyperus sp.	4	4	0.125	5.714	0.125	2.162	1,000	3.252	11.129
Pterocaulon virgatum	4	7	0.125	5.714	0.219	3.784	1.750	5.691	15.189
Aristida longiseta	1	2	0.031	1.429	0.063	1.081	2,000	6.504	9.014
Imperata brasiliensis	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Andropogon biconis	3	7	0.094	4.286	0.219	3.784	2.333	7.588	15.658
Vernonia westiniana	5	13	0.156	7.143	0.406	7.027	2.600	8.456	22.625
Desmodium incanum	13	47	0.406	18.571	1.469	25.405	3.615	11.758	55.735
Neonotonia wightii	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hyptis suaveolens	2	2	0.063	2.857	0.063	1.081	1,000	3.252	7.190
Solanum aculeatissimum	5	13	0.156	7.143	0.406	7.027	2.600	8.456	22.625
Miconia neourceolata	1	1	0.031	1.429	0.031	0.541	1,000	3.252	5.221
Mimosa pudica	2	2	0.063	2.857	0.063	1.081	1,000	3.252	7.190
Spermacoce sp.	1	1	0.031	1.429	0.031	0.541	1,000	3.252	5.221
Pteridium sp.	5	22	0.156	7.143	0.688	11.892	4.400	14.309	33.344
Paspalum notatum	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Centella asiatica	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Triumfetta sp.	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Indigofera hirsuta	2	2	0.063	2.857	0.063	1.081	1,000	3.252	7.190
Miconia albicans	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mikania cordifolia	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Stylosanthes viscosa	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	-	**185**	**2.18**	**100.00**	**5.78**	**100,00**	**30.74**	**100,00**	**300.00**

Source: The authors (2023).

Table 6. Number of squares in which the species was found (NQ), number of plants (NP), frequency (F), relative frequency (RF) (%), density (D) (plants m^{-2}), relative density (RD) (%), abundance (A), relative abundance (RA) (%) and relative importance index (RII) (%) of weeds occurring in pasture areas relative to the level of degradation N_2. Municipality of Cachoeiras de Macacu, State of Rio de Janeiro, 2023.

	N_2								
Scientific name	**NQ**	**NP**	**F**	**RF**	**D**	**RD**	**A**	**RA**	**RII**
Sporobolus indicus	9	53	0.281	7.759	1.656	5.561	5.889	4.246	17.566
Eupatorium maximilianii	19	180	0.594	16.379	5.625	18.888	9.474	6.830	42.097
Cyperus sp.	6	19	0.188	5.172	0.594	1.994	3.167	2.283	9.449
Pterocaulon virgatum	16	42	0.500	13.793	1.313	4.407	2.625	1.892	20.093
Aristida longiseta	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Imperata brasiliensis	8	295	0.250	6.897	9.219	30.955	36.875	26.585	64.436
Andropogon biconis	8	135	0.250	6.897	4.219	14.166	16.875	12.66	33.228
Vernonia westiniana	2	2.	0.063	1.724	0.063	0.210	1,000	0.721	2.655
Desmodium incanum	14	55	0.438	12.069	1.719	5.771	3.929	2.832	20.673
Neonotonia wightii	4	9	0.125	3.448	0.281	0.944	2.250	1.622	6.015
Hyptis suaveolens	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Solanum aculeatissimum	1	12	0.031	0.862	0.375	1.259	12,000	8.651	10.773
Miconia neourceolata	8	37	0.250	6.897	1.156	3.883	4.625	3.334	14.113
Mimosa pudica	3	6	0.094	2.586	0.188	0.630	2,000	1.442	4.658
Spermacoce sp.	3	9	0.094	2.586	0.281	0.944	3,000	2.163	5.693
Pteridium sp.	2	42	0.063	1.724	1.313	4.407	21,000	15.140	21.271
Paspalum notatum	3	12	0.094	2.586	0.375	1.259	4,000	2.884	6.729
Centella asiatica	5	40	0.156	4.310	1.250	4.197	8,000	5.768	14.275
Triumfetta sp.	2	2	0.063	1.724	0.063	0.210	1,000	0.721	2.655
Indigofera hirsuta	3	3	0.094	2.586	0.094	0.315	1,000	0.721	3.622
Miconia albicans	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mikania cordifolia	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Stylosanthes viscosa	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	-	**953**	**3.62**	**100.00**	**29.78**	**100.00**	**138.70**	**100.00**	**300.00**

Source: The authors (2023).

Table 7. Number of squares in which the species was found (NQ), number of plants (NP), frequency (F), relative frequency (RF) (%), density (D) (plants m^{-2}), relative density (RD) (%), abundance (A), relative abundance (RA) (%) and relative importance index (RII) (%) of weeds occurring in pasture areas relative to the level of degradation N_3. Municipality of Cachoeiras de Macacu, State of Rio de Janeiro, 2023.

	N_3								
Scientific name	**NQ**	**NP**	**F**	**RF**	**D**	**RD**	**A**	**RA**	**RII**
Sporobolus indicus	9	57	0.281	10.463	1.781	2.350	6.333	2.726	15.539
Eupatorium maximilianii	9	568	0.281	10.463	17.750	23.413	63.111	27.168	61.044
Cyperus sp.	9	2	0.281	10.463	0.063	0.082	0.222	0.096	10.641
Pterocaulon virgatum	11	35	0.344	12.788	1.094	1.443	3.182	1.370	15.601
Aristida longiseta	1	1	0.031	1.163	0.031	0.041	1,000	0.430	1.634
Imperata brasiliensis	8	392	0.250	9.301	12.250	16.158	49,000	21.094	46.552
Andropogon bicornis	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Vernonia westiniana	3	3	0.094	3.488	0.094	0.124	1,000	0.430	4.042
Desmodium incanum	8	213	0.250	9.301	6.656	8.780	26.625	11.462	29.542
Neonotonia wightii	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hyptis suaveolens	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Solanum aculeatissimum	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Miconia neourceolata	2	2.	0.063	2.325	0.063	0.082	1,000	0.430	2.838
Mimosa pudica	1	4.	0.031	1.163	0.125	0.165	4,000	1.722	3.049
Supermacoce sp.	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Pteridium sp.	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Paspalum notatum	16	1,130	0.500	18.601	35.313	46.578	70.625	30.403	95.582
Centella asiatica	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Triumfetta sp.	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Indigofera hirsuta	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Miconia albicans	5	6	0.156	5.813	0.188	0.247	1.200	0.517	6.577

Mikania cordifolia	3	12	0.094	3.488	0.375	0.495	4,000	1.722	5.704
Stylosanthes viscosa	1	1	0.031	1.163	0.031	0.041	1,000	0.430	1.634
	-	**2,426**	**2.68**	**99.98**	**75.81**	**99.99**	**232.29**	**100.00**	**300.00**

Source: The authors (2023).

Table 8. The similarity index (%) of weed species occurring in three levels of degradation of pastures in the municipality of Cachoeiras de Macacu, State of Rio de Janeiro.

Degradation levels	**N_2**	**N_3**
N_1	78.78	62.06
N_2	-	62.50

N_1: low degradation; N_2: moderate degradation; N_3 strong.
Source: The authors (2023).