ECOTRÓPICOS

Research article

Changes in the floristic composition of agroecologically managed savannas located in the north of Amazonas State-Venezuela

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Abstract: In savannas in northern Amazonas state subjected to agroecological management (minimum tillage and addition of organic and inorganic sources of phosphorus), the effect of phosphorus on floristic composition and vegetation diversity in an ecological succession was determined through an experimental design of three main treatments of inorganic amendments with phosphorus sources such as NPK, phosphate rock (Rf) and control (C) and four subtreatments with organic amendments with phosphorus sources: organic manure (Ao), green manure (Av), green manure plus organic manure (Ao+Av) and natural savanna (Sn) respectively. The experimental field consisted of 48 plots of 16 m m^2, where 36 were disturbed with plowing and sowing of Vigna unguiculata var. Tuy, which forms an induced early succession, and the different organic and inorganic amendments described above were applied. The remaining 12 plots were control treatments that were neither plowed nor sown (early natural succession). The vegetation established one year after the system was disturbed and agroecologically managed presented important changes in the floristic composition with respect to the natural savanna, showing an increase in the richness of species. These changes were associated with secondary successional processes, which presented greater biodiversity with NPK Ao management. There was an ecological shift of the dominant species from *Trachypogon vestitus* in the natural savannas to *Borreria aristeguietana* in the intervened savannas. These results emphasize the need for medium and long-term studies to monitor the successional trajectory on a large scale.

Keywords: Agroecology; Biodiversity; Floristics; Early ecological succession.

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Introduction

Savannas are tropical ecosystems characterized by a herbaceous component, with an ecologically dominant continuous layer composed of grasses and sedges, in which a discontinuous tree layer may be present (Silva, 2003). These ecosystems are subject to disturbances resulting from agricultural or livestock management in South America, which causes alterations in their biodiversity that lead to a reduction in their productivity, associated with a decline in soil fertility when these savannas are abandoned, giving rise to succession processes (Pérez, 2002). In the Venezuelan Amazon region, the savannas are seasonal macrothermal and cover some 20,000 km^2, or 12% of the area, while the remaining 88% is covered by forests. These savannas present certain agronomic limitations associated with low natural fertility and the high erosive capacity of their soils (López-Hernández, 1990a).

The savannas of the Venezuelan Llanos, particularly those located along the Orinoco–Apure river system, present significant agronomic limitations associated with low natural fertility and the high susceptibility of their soils to erosion processes (López-Hernández, 1990b). These edaphic conditions restrict productive potential and increase the vulnerability of these ecosystems to anthropogenic disturbances, limiting their capacity for recovery and resilience (Sarmiento, 1984; Scholes & Archer, 1997).

Historically, the Orinoco–Apure corridor has been viewed as a strategic area for territorial development in Venezuela, focused on riverine integration and the utilization of natural resources. Currently, this region is experiencing intensified land use characterized by the expansion of agricultural, forestry, oil, and mining activities—both formal and informal—which has significantly increased pressure on natural ecosystems (RAISG, 2022). In particular, mining in the southern Orinoco has been identified as one of the main drivers of environmental degradation, causing deforestation, water pollution, and habitat fragmentation (RAISG, 2022).

Various studies have documented a sustained loss of vegetation cover in Venezuela over the past decades, with direct impacts on biodiversity and ecosystem services (Hansen et al., 2013; RAISG, 2022). This process is exacerbated by unsustainable land-use practices, which alter ecological succession trajectories and limit the natural regeneration of vegetation (Chazdon, 2014). In savanna ecosystems, where disturbance dynamics are key determinants of vegetation structure and composition, intensive human intervention can lead to significant changes in the diversity and functionality of plant communities (Bond & Parr, 2010; Lehmann et al., 2014).

Despite the ecological and productive importance of these savannas, available information on the floristic composition and ecology of plant communities associated with the Orinoco–Apure corridor remains limited and fragmented. This knowledge gap constitutes a critical constraint for the formulation of sustainable management and conservation strategies, particularly in landscapes undergoing rapid transformations resulting from intensive land use. In this context, detailed floristic studies conducted in nearby regions of Venezuelan Guayana have highlighted the need to strengthen knowledge about the plant diversity of these ecosystems, underscoring the existence of significant information gaps even in relatively accessible areas (Nozawa Furuya et al., 2019). Likewise, it has been noted that significant gaps in floristic knowledge persist in Amazonian savanna ecosystems, especially regarding herbaceous components and in poorly explored areas, reinforcing the need to develop detailed inventories and comprehensive vegetation studies (Devecchi et al., 2020).

Knowledge of the composition, structure, and dynamics of plant communities is essential for establishing agronomic management guidelines aimed at utilizing resources with the least possible impact on biodiversity, especially in contexts of disturbance and early succession (Chazdon, 2014; Walker & Moral, 2003). In this context, the use of organic and inorganic amendments has been proposed as a strategy to improve soil conditions and promote ecological restoration processes in degraded systems (Lal, 2015; Tiessen et al., 1994).

Therefore, the objective of this study was to evaluate the impact of different organic and inorganic amendments on the natural plant community one year after system disturbance, under conditions of induced early succession. The evaluation was based on changes observed in the structural and compositional attributes of the plant community, as well as through the compilation of a floristic inventory of the study area. The results obtained aim to contribute to the development of a scientific foundation that will allow for the reconciliation of current land-use dynamics in the Orinoco–Apure corridor with biodiversity conservation in the Venezuelan Llanos.

Methods

Study Area

It was located in the Agropecuaria San Diego (06° 10′ N; 67° 17′ W), located in the Cedeño District of Bolívar State, approximately 90 km from Puerto Ayacucho, at 80 m.a.s.l. The characteristic vegetation of this locality is represented by *Trachypogon* savannas *sensu* Ramia (1967), which represents the most widely distributed grass genus (family Poaceae) in Venezuelan savannas. According to Szczerban (1974), the geology of the area is characterized by acid igneous rocks belonging to the Parguaza granite, a large part of which is covered by alluvium and residual soils. The soils belong to the Typic Ustipsamments group, following the Soil Survey Staff (1999) classification, with a high proportion of sand (up to 1m depth), light structure, weak granular structure that allows high permeability through the profile, extreme acidic pH (4.5), low content of exchangeable bases and low percentages of organic matter and available phosphorous (Nazoa, 1980).

There is a marked climatic bistationality in the area, with a rainy period from mid-March to November (June and July being the months with the highest precipitation), and a dry period from December to March (Pérez, 2002), characterized by intense and long-lasting rainfall, with 6 perhumid months with precipitation greater than 100 mm. The average annual precipitation is 1,862 mm, and the average annual temperature is 28.4°C (isothermal temperature regime, with variations of less than 5°C between the hottest and coldest months).

Experimental design

In September 2001, a randomized block plot system was set up in the field, consisting of 48 plots of 16m^2, of which 36 were plowed motocultor and sown with Vigna unguiculata var Tuy using a motorized cultivator (a small-scale agricultural tool operated by a person who walks behind it to prepare and turn the soil) and the remaining 12 plots served as control treatments for the effects of early secondary succession. The experimental treatments in the 36 plowed and sown plots consisted of three main treatments: NPK (14:14:14), rock phosphate (Rf) and a control (C), without inorganic amendments. Each of the above included in turn four sub-treatments: Ao, Av, AvAo and Sn, which identify, organic manure of animal origin, green manure Imperata contracta (grass colonizer of intervened environments), green manure plus organic manure and natural savanna. The doses were equivalent to 200, 163, 450 and 7500kg Ha^{-1} of NPK, Rf, Ao and Av, half of the above organic doses received the combined organic sources treatment. Each treatment included three randomly distributed field replicates (Fig. 1). Treatments were assigned to each plot using a random number table, a procedure that allowed them to be randomly distributed within each experimental block, ensuring an unbiased distribution and reducing potential biases in the comparison of the effects of each treatment on the evaluated variables (Gómez & Gómez, 1984).

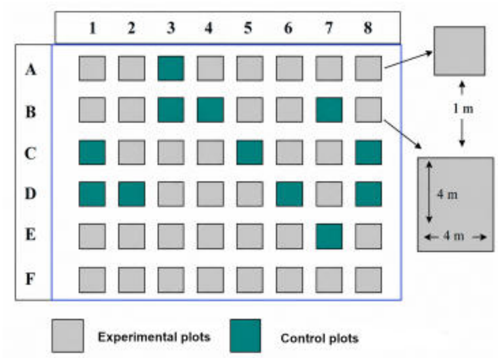

Figure 1: Spatial distribution of the experimental plots in the field, with each plot identified by letters (A–F) and numbers (1–8) within the experimental design. Gray squares represent plowed and seeded plots, while green squares indicate unseeded control plots. Each sampling subplot corresponds to 1 m^2 within 4 × 4 m plots.

Inventory technique

The floristic reconnaissance was carried out at the beginning of the experiment (October-November 2000) and one year after the system was disturbed in each 16m^2 experimental plot, where a 1m^2 subplot was delimited to quantify and identify all the plants present. The percentage of cover was estimated visually for each one of them. The botanical samples collected (collection permit of Dr. Tatiana Wikander) were identified through the use of specialized bibliography, consultation with experts, and comparison with the material deposited in the National Herbarium (VEN). Plants were identified, where possible, to species level, at the Instituto Jardín Botánico de Caracas and with comparisons with samples from the National

Herbarium. Specimens were deposited in the latter herbarium. The scientific names of the plant species were validated using the available bibliography for this purpose (Judziewicz, 1991; Ramia, 1967; 1974; Ramia & Stauffer, 2003; Steyermark et al., 1995).

Data analysis

Biological diversity was estimated through the Shannon-Weaver Diversity Index. The Importance Value Index (IVI) was calculated taking into account the sum of three variables: frequency, density and relative cover of each species. Total richness was determined by the number of species present in each community.

A principal component analysis (PCA) was performed to evaluate the weight that the variables (agroecological management with organic and inorganic amendments) can have in the differentiation of the floristic composition. The extraction method was principal component analysis, with Varimax rotation method with Kaiser normalization with the SPSS 12.0 program (IBM SPSS Statistic 28.0).

Results

Biodiversity

Figure 2 shows how after one year of exclusion of grazing and without any agroecological management in the control community there is a decrease in the biodiversity of families, genera and species with respect to the original savanna community. In contrast to the above, the savanna communities that are established one year after being subjected to agroecological management show a high floristic biodiversity of families, genera and species (greater richness) with respect to the Witness community. The community with the highest biodiversity was the one associated with NPK Ao agroecological management, with 10 families, 19 genera and 22 species.

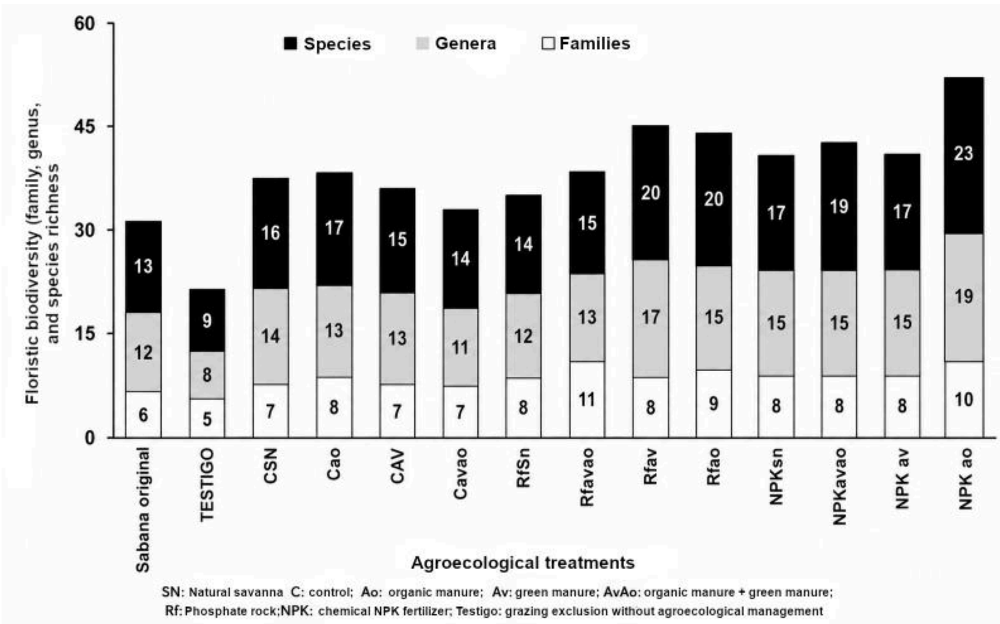

Figure 2: Floristic biodiversity (richness of families, genera, and species) in original savanna, control, and savanna communities subjected to different agroecological managements with organic and inorganic amendments. SN: natural savanna; C: control; Ao: organic manure; Av: green manure; AvAo: organic manure + green manure; Rf: phosphate rock; NPK: chemical NPK fertilizer; Testigo: grazing exclusion without agroecological management.

The other management options show more slight variations in floristic biodiversity when compared to each other (Fig. 1).

Figure 3 shows the increase in the biodiversity of families after one year of agroecological management (from 5 to 11) together with the disappearance of others (as is the case of the Gentianaceae family), with respect to the original savanna community.

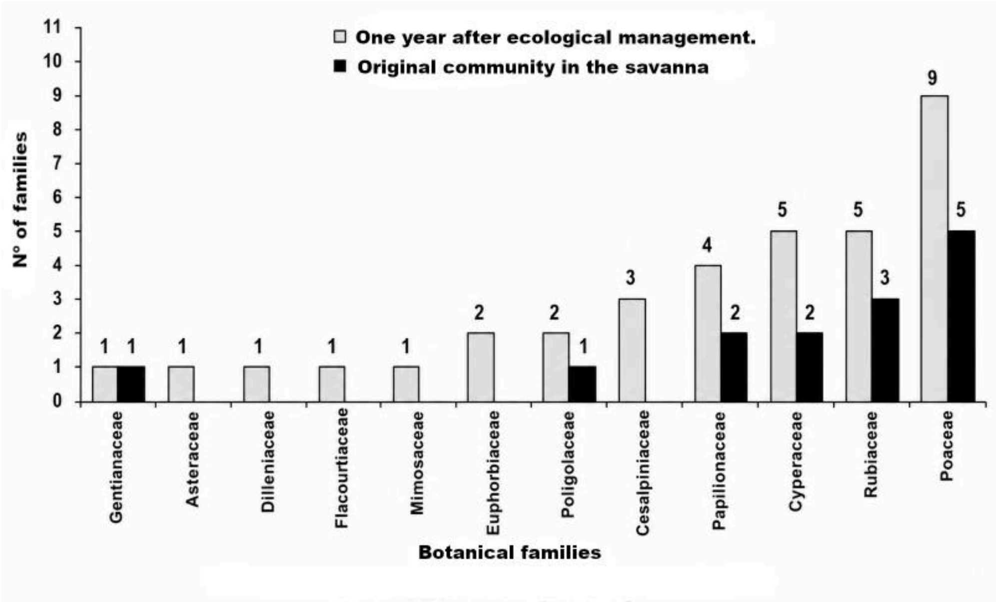

Figure 3: Comparison of the number of botanical families present in the original savanna community and in communities established one year after agroecological management. Botanical families are shown in increasing order according to the number of registered families in the community in the year of agro-ecological management.

Table 1 shows the values of the Shannon-Weaver diversity index for this work and other communities. The results indicate a similarity with the value reported by Santander (2003), but higher than those reported by Susach (1984), Grillo (1983) and Guinand (1979).

Table 1: Shannon diversity values for *Trachypogon sp* savannas.

Author and location	Shannon-Weaver Diversity Index (H')
This work (witness)	0.74
Santander (Agropecuaria San Diego, 2003)	0.798
Susach (Estados Guárico, Apure, Bolívar, 1984)	0,42 - 0,65
Grillo (Puerto Ayacucho, 1983)	0,39 - 0,54
Guinand (Estado Amazonas, 1979)	0.58

Table 2 shows the diversity index of all the communities planted in the agroecologically managed savannas, showing an increase in diversity in the communities associated with agroecological management, except in the treatment of phosphate rock without organic phosphorus source (**RfSn**). This reflects the important role of equity in the diversity index and a possible effect of phosphate rock management on species biodiversity.

Table 2: Shannon diversity values for *Trachypogon sp* savannas under agroecological management.

	Control				NPK				Rf			
Management	Ao	Av	AoAv	Sn	Ao	Av	AoAv	Sn	Ao	Av	AoAv	Sn
H'	0.8	0.88	0.83	0.87	0.99	0.95	0.95	0.83	0.82	0.8	0.73	0.48

Floristic composition

Figure 4 shows the floristic composition and the Importance Value Index (IVI) for each species in each community planted in the different agroecological management alternatives evaluated, showing that the species Borreira aristegueitana, typical of the rainy season and rainy season, followed by Mesosetum chaseae and *Poligala* sp.

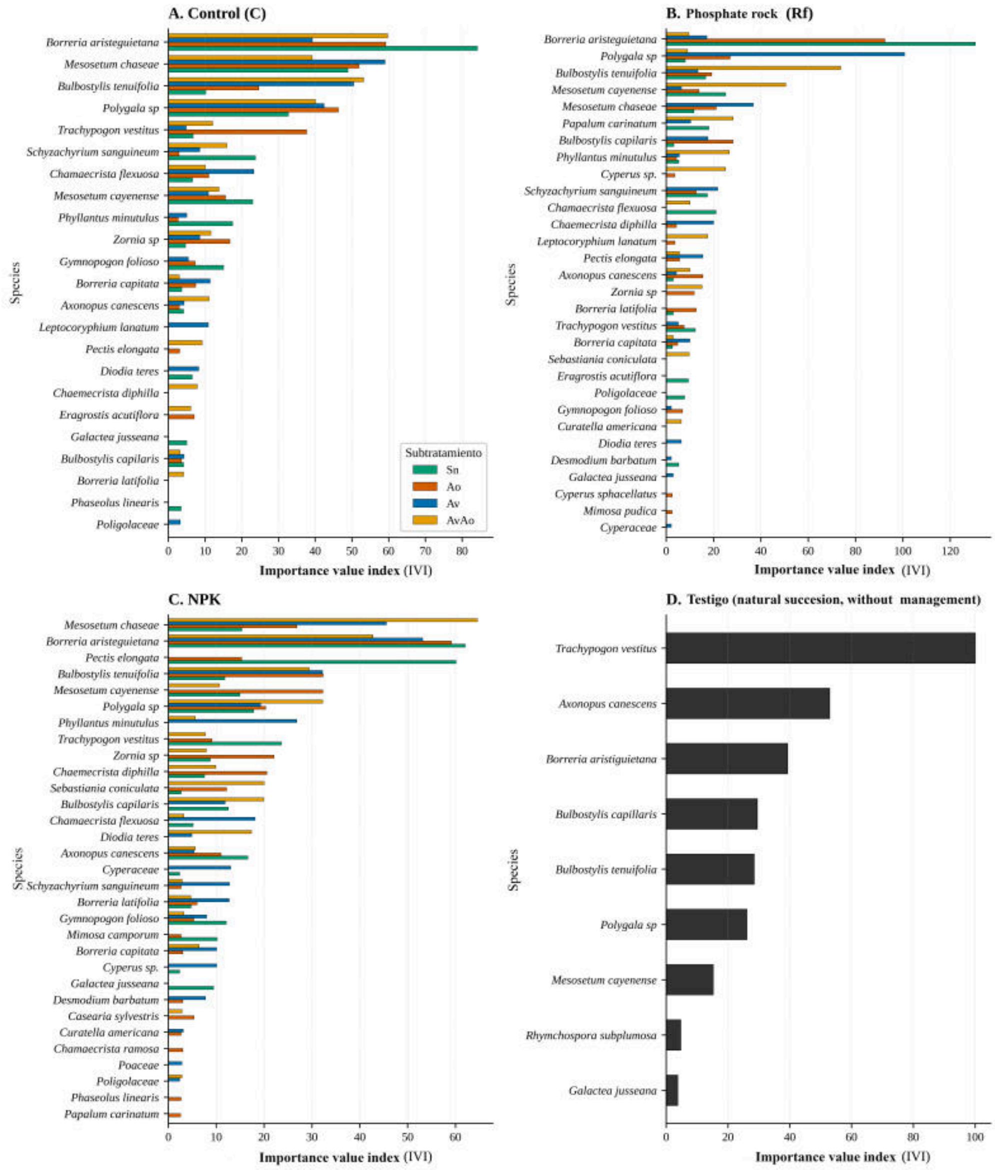

Figure 4: Floristic composition and Importance Value Index (IVI) of species present in communities subjected to different agroecological management alternatives. C: control; Sn: natural savanna; Ao: organic manure; Av: green manure; AoAv: organic manure + green manure; NPK: chemical NPK fertilizer; Rf: phosphate rock.

Principal component analysis

The purpose of this analysis was to establish the correlations between the disturbances studied (agroecological management) and the vegetation present. As shown in Table 3, the third component analysis accumulated 80.97% of the variance.

Table 3: Variability percentage and total accumulated variance.

	Component 1	**Component 2**	**Component 3**
Variability (%)	56.897	14.701	9.378
Accumulated %	**56.897**	**71.598**	**80.976**

The factorial loadings (Table 4) show that in the first component (1) the weight of the variables associated with the amendments with inorganic enrichment determines the species dominance in these treatments; on the other hand, the second component (2) represents the impact generated by the removal of the original vegetation and the mechanical disturbance, and the third component reflects the effect of the organic treatments.

Table 4: Factorial loadings (Component matrix) after Varimax rotation.

	D1	D2	D3
CSN	0.801	−0.057	0.494
CAVAO	0.630	0.087	0.722
CAV	0.384	0.041	0.896
CAO	0.625	0.307	0.658
RfAo	0.899	0.058	0.321
RfAv	0.105	0.139	0.754
RfAvAo	0.048	−0.143	0.436
RfSn	0.941	−0.081	0.125
NPK Ao	0.777	−0.022	0.480
NPK Av	0.602	−0.090	0.639
NPK Av Ao	0.461	0.083	0.780
NPK Sn	0.801	0.203	0.084
Witness	0.028	0.934	0.191
Natural savanna	0.047	0.936	−0.155

Figure 5 presents the factorial plane for each of the evaluated variables contrasted with the cases (species present), showing how agroecological management (organic amendments of green manure) form a group that coincides with the presence of species such as *Polygala* sp, *Mesosetun chaseae* and *Bulbostylis tenuifolia*.

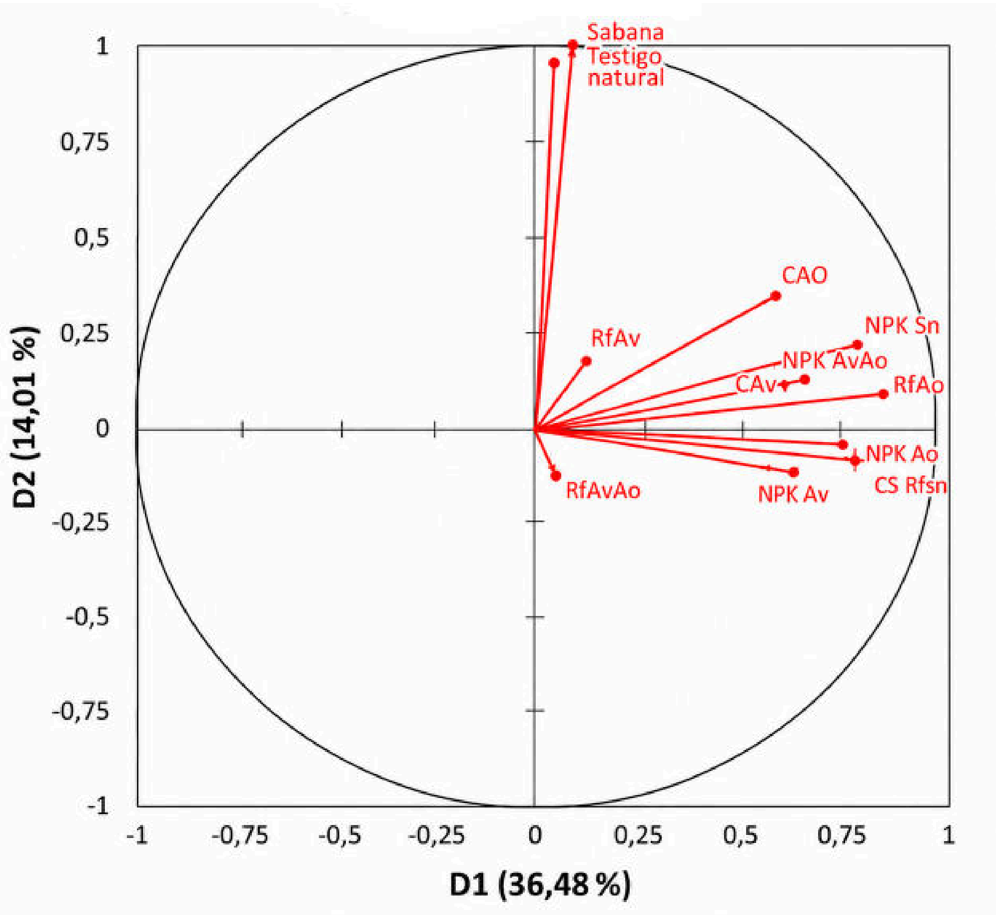

Figure 5: Principal Component Analysis (PCA) of agroecological treatments based on species richness after Varimax rotation. SN: natural savanna; C: control; Ao: organic manure; Av: green manure; AvAo: organic manure + green manure; Rf: phosphate rock; NPK: chemical NPK fertilizer; Witness: grazing exclusion without management.

It can be observed how there is a marked distribution of species dominance according to the inorganic or organic enrichment applied, with *Borreria aristeguietana* being associated with inorganic amendments and organic manure. On the other hand, *Borreria capitata*, *Poligala* sp and *Rhinchospora* form another separate group close to the presence of *Trachypogon* and *Axonopus*, the presence of these groups is associated with component 2, these species are present in the treatments or control and natural savanna that were not disturbed neither by plowing nor by the removal of the original vegetation.

Discussion

It is known that biodiversity in savannas is regulated by a number of factors and processes, among which the seasonality of water availability in the soil is one of the main conditioning factors (Goldstein & Sarmiento, 1987; Sarmiento, 1984), together with the availability of nutrients, so it can be that through treatments that improve soil moisture and increase the availability of nutrients it will present a greater biodiversity. Although this greater biodiversity is not associated with the initial conditions of the ecosystem, the values of the Shannon-Weaver Diversity index for this work indicate a similarity with the value reported by Santander (2003), for a work carried out in the same study area. Both values are higher than those reported by Susach (1984) for *Trachypogon* savannas in Guárico and in savannas located near Pto. Ayacucho by Grillo (1983) and Guinand (1979).

The decrease in biodiversity shown by savannas excluded from grazing is widely documented for *Trachypogon* savannas in the literature (San José & Fariñas, 1983; Sarmiento, 1996; Silva, 2003), and can be attributed to the fact that these systems have evolved in the Neotropics without the greater pressures exerted by grazing by large herbivores, which is considered a factor that generates low stability in savannas and Neotropical herbaceous ecosystems (Sarmiento, 1992). The absence of grazing and agroecological management causes an increase in Trachypogon biomass that does not allow other less competitive species to colonize the spaces (Pérez, 2002).

The different types of management involve plowing with removal of the original savanna vegetation, thus acting as an ecological disturbance, which with the given rest period (1 year) gives rise to an early secondary successional process in an abandoned field, which is characterized by the colonization of pioneer species in the early stages (Pérez, 2002; Wikander, 1999). The increase in floristic biodiversity at the level of families, genera and species in the different communities subjected to organic and inorganic management (disturbances) can be attributed to the successional process originated by agroecological management, evidencing a process of species turnover characteristic of the successional stages and could imply a fragility and low resilience of the ecosystem. It is clear, then, the need for further studies on the use of agroecological alternatives and their effect on vegetation dynamics.

Finally, we can infer a relationship between biodiversity and applied agroecological management visualized by the response of vegetation dynamics to the use of inorganic P sources associated with organic manure. These results emphasize the need to go deeper in terms of observation periods and repetition of experimental doses.

The differences found in the diversity values are probably due to the proximity of the savanna community under study to the "inselbergs", where there is a completely different vegetation, presenting the possibility of a minority presence of species belonging to this ecosystem in the savanna (Santander, 2003). In these communities there are species such as Mesosetum cayenense reported for the cerrado of Amapa in Brazil (Mochiutti & Meirelles, 1994) and in Venezuela only for the "inselbergs" (Ramia, personal communication), which gives it a character of importance at the level of floristic biodiversity in terms of its conservation. This fact suggests a biodiversity conservation importance for these savannas including the presence of endemic species.

Apparently, the trajectory of the successional process is directed by plowing and removal of vegetation in the first instance followed by the agroecological management used (combinations of organic and inorganic fertilizers), with the dominant species for most forms of management being *Borreria aristeguietana*, *Mesosetum chaseae* and *Polygala* sp. (associated with the application of inorganic sources combined with organic fertilizers). In particular, *Borreria aristeguietana*, whose flowering process begins between July and October (Delascio Chitty, 1981) and is recognized by Galán de Mera et al. (2006) as a species endemic to the Venezuelan plains, is the most dominant.

The ordering of the treatments (agroecological management) in terms of the resulting vegetation was carried out through a Principal Components Analysis (PCA), of the centered correlation matrix, and Varimax through which it was intended to establish the existing interrelationships between the disturbances studied and the present vegetation. The analysis of the third component accumulated 80.97 % of the variance. The resulting order in the first two principal components (Figure 4 and 5), shows how the savannas managed with green manures form two groups that coincide with the presence of species such as *Polygala* sp, *Mesosetun chaseae* and *Bulbostylis tenuifolia.* This suggests an effect of agronomic promotion on the plant community that settles after the disturbance. The original plants of these plains ecosystems (savannas with good internal drainage) such as *Trachypogon vestitus*, *Axonopus canescens* and *Bulbostylis capilaris* are associated with the original savanna, control savanna and treatments without combined sources or green manures, the predominance of these species in well-drained savannas I consistent with the findings of Dezzeo et al. (2008), who identified them as dominant floristic elements of the natural vegetation ef the Easter Orinoco Llanos, associated with restrictive edaphic conditions and the characteristic ecological dynamics of these ecosystems.The presence of organic amendments as a soil conditioner apparently benefits the dominance of *Borreria aristeguietana* in the treatments.

This indicates a change in the original floristic composition and ecological displacement of *Trachypogon* sp and *Axonopus canescens* by the aforementioned species. This ecological displacement can be attributed to the early successional process caused by the disturbance generated by the different types of agroecological management evaluated, as well as to the effect of improved soil quality in terms of moisture retention and a better supply of plant-available nutrients such as phosphorus (c.f., Pérez, 2002).

These results emphasize the need to evaluate in the "long term" the impact of agroecological management alternatives on plant biodiversity and the stability of savanna ecosystems in their different types, as well as the effects of grazing activities and the introduction of pastures and crops. It is also necessary to know aspects of the dynamics of the succession of plant communities and their capacity for recovery (resilience) in the face of different forms of management.

Although these can be considered rather are isolated observations, the systematic recovery of biodiversity use in ecological and economic terms is a national priority for the Venezuelan savannas located in the Orinoco-Apure development axis, which have a broad ecological connotation, not only for their physiognomic, structural and functional biodiversity, but also for the fauna which is associated with these communities.

In the studied communities located in the north of Amazonas State, there are species of conservation relevance due to their endemic character, such as Borreria aristegueitana (Galán De Mera et.al, 2006) from the savannas of the western plains of the Venezuelan Orinoco and Mesosetum cayenense (from inselbergs of Amapá to Venezuelan Guayana). The increase in floristic biodiversity at the level of families, genera and species in the different communities should be attributed to the successional process originated by agroecological management. The greatest biodiversity is associated with NPK Ao agroecological management. Green manure treatments promoted distinct floristic assemblages, primarily associated with pioneer species such as *Polygala* sp., *Mesosetum chaseae*, and *Bulbostylis tenuifolia*, suggesting that these amendments act as an ecological filter on the plant community. Although this management practice increased floristic richness, it also generated changes in the original composition of the savanna, favoring a succession pathway distinct from that dominated by *Trachypogon vestitus* and *Axonopus canescens*. Consequently, the observed increase in biodiversity should be interpreted as an expression of secondary succession induced by disturbance and soil improvement, rather than as an ecological recovery of the natural community.

Conclusions

It is concluded that in the savannas of northern Amazonas State, agroecological management based on minimum tillage and the incorporation of organic and inorganic sources of phosphorus improves soil quality, particularly in terms of moisture retention and nutrient availability, which significantly increases plant diversity during the early stages of secondary succession. The NPK treatment combined with organic fertilizer exhibited the highest biodiversity, confirming that soil improvement favors the establishment of more diverse plant communities. However, this increase in diversity was associated with processes of floristic replacement and ecological displacement of dominant species typical of the natural savanna, such as *Trachypogon vestitus* and *Axonopus canescens*, by pioneer and opportunistic species such as *Borreria aristeguietana*, *Mesosetum chaseae*, and *Polygala* sp., indicating that these changes result from successional trajectories induced by disturbance and management, rather than a recovery of the ecosystem's original composition. Green manure treatments, furthermore, promoted specific floristic assemblages, indicating that different management alternatives act as ecological filters capable of modifying the direction of plant succession. Consequently, although agronomic promotion alternatives may increase biodiversity in the short term, their impact on the stability, resilience, and conservation of savanna ecosystems requires medium- and long-term evaluations, also considering the effect of grazing, the introduction of pastures and crops, as well as the successional dynamics and recovery capacity of these communities in the face of different management practices. These results emphasize the need to extend observation periods and increase the number of experimental replicates to more accurately understand the ecological sustainability of these practices.

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Data availability

Data available at: https://doi.org/10.53157/ecotropicos.kmg9-pxr2

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- Formal analysis:
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- Methodology
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- Writing – original draft
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- Writing – review & editing
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Resumen: Cambios en la composición florística de sabanas manejadas agroecológicamente ubicadas al norte del Estado Amazonas-Venezuela

En sabanas al norte del Estado Amazonas sometidas a manejo agroecológico (labranza mínima y adición de fuentes orgánicas e inorgánicas de fósforo) se determinó el efecto de este sobre la composición florística y la diversidad de la vegetación en una sucesión ecológica temprana, mediante un diseño experimental de tres tratamientos principales de enmiendas inorgánicas como fuentes de fósforo tales como NPK, roca fosfórica (Rf) y control (C) y cuatro subtratamientos con enmiendas orgánicas como fuentes de fósforo : abono orgánico (Ao), abono verde (Av), abono verde más abono orgánico (Ao+Av) y sabana natural (Sn) respectivamente). El campo experimental estuvo conformado por 48 parcelas de 16mm^2, donde 36 fueron perturbadas con arado y siembra de Vigna unguiculata var. Tuy, lo que conforma una sucesión temprana inducida, y se les aplicaron las diferentes enmiendas orgánicas e inorgánicas descritas anteriormente. Las 12 parcelas restantes fueron tratamientos testigo no arados ni sembrados (de la sucesión natural temprana). La vegetación que se establece al año de perturbado y manejado agroecológicamente el sistema presenta cambios importantes en la composición florística con respecto a la sabana natural, notándose un incremento en la riqueza de especies. Estos cambios estuvieron asociados a procesos sucesionales secundarios, que presenta mayor biodiversidad con el manejo de NPK Ao. Ocurre un desplazamiento ecológico de la especie dominante, pasando del *Trachypogon vestitus* en las sabanas naturales a la Borreria aristeguietana en las sabanas intervenidas. Estos resultados enfatizan la necesidad de estudios a mediano y largo plazo para monitorear la trayectoria sucesional a gran escala.

Keywords:
Agroecología, biodiversidad, florística, sucesión ecológica temprana.

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