Assessment of Grass Composition and Distribution Pattern on Pipeline Right-of-Way in Bayelsa State and its Potential Use for Dominant Grazers

Abstract

This study investigates grass diversity and distribution pattern along a pipeline linear corridor in two Local Government Areas in Bayelsa State and the feasibility of utilizing them for cattle grazing. The term grass is applied in this paper to describe a variety of vegetation forms, exclusively composed of herbaceous plants. Random pair sampling design was used, and species richness and evenness were determined using the taxonomic data obtained. The results revealed nineteen families and were represented in four different growth habits. The most often encountered families were Poaceae, Cyperacaee, and Asteraceae. Sixty-seven (67) species were sampled in the Ogbia pipeline corridor, and 66 species in Yenagoa. Sixty-six of the species had 99% occurrence on both sites. Poaceae and Cyperaceae account for two-thirds of the entire species recorded, and were the prevalent by growth habits. Herbs ranked second, the majority of which were Asteraceae; other growth habits observed were vines, and ferns. Vines were rare in occurrence, whereas ferns clumped in their distribution pattern. Simpson index values of 0.023 and 0.026 and Shannon-Wiener index values of 3.953 and 3.346 were recorded in Ogbia and Yenagoa sites, respectively. The evenness index values (0.003 and 0.003) and Margalef values (7.449 and 7.329) were also obtained from the two sites, respectively. The highest species density in Ogbia was observed for *P. laxum* (7.93m^2), while *L. haxandra* yielded the highest mean density of 9.42m^2 in Yenagoa. *A. compressus, O. longistamiinata,* and *A. gangetica* recorded the highest frequency index (70%) in Ogbia, whereas, *A. compressus* constituted the highest frequency index (75%) in Yenagoa, followed by *O. corymbosa* and *P. maximum* (70%) each. The ability of these species to thrive in pipeline corridor conditions underscores the potential use of the corridor as alternative grazing lands.

Keywords: Grass diversity, Pipeline, Right-of-Way, Cattle, Bayelsa State

Introduction

Grass diversity plays a crucial role in pastoral contexts worldwide. It contributes to the overall health and functionality of natural environments by providing food, shelter, and other resources for a wide range of organisms (Fraser et al., 2022). Unlike pristine forest plants, grasses are more dynamic in nature, filling available land and trying to establish their dominance in a short while in open space (Zimmermann et al., 2015; Lubke, 2023). The composition of grass and their spatial arrangement within a landscape are critical to the pursuit of environmental management and sustainable livestock farming (Gibon, 2005). Managing livestock, land, and grass resources as an integrated system promotes ecological balance and resilience (Udayakumar et al., 2021).

Cattle as the commonest livestock in African pastoralism (Turner, 2015; Tamou et al., 2018), they have been identified as the predominant grazers in Nigeria, providing 45% of the country's total meat consumption (Ladele, 1996; Kubkowa, 2017; Adekanmi et al., 2017). FOA (2019) and NCCG (2023) put Nigerian cattle at about 20 million. Cattle in Nigeria are raised extensively either in small holders or large herds by semi-sedentary and transhumant pastoralists, who run more than 80% of the Nigeria cattle (Suleiman *et al*., 2015). Their production in the pastoral system revolves around herdsmen, mobile livestock, and rangelands (Leeuw et al., 2020). According to Grandval (2012), the pastoral system attempts to maximize productivity by exploiting grazing imbalances; the system offers affordable, high-quality proteins and nutrients to meet local demand and help reduce a country's reliance on imports (FAO, 2021). Several studies, including Leeuw et al. (2020) and Grandval (2012), asserted that sub-Saharan Africa's pastoral systems are 20% more productive than sedentary animal rearing systems, but these often lead to conflict between herders and farmers in all locations where it is practiced in Nigeria (Hussein et al., 1999; Brotten, 2021).

Bayelsa State, like other states in Nigeria, is confronted with the problem of indiscriminate grazing of forests and farmlands, raising concerns such as land degradation and conflicts resulting from competition for resources (Adisa, 2012; Ofuoku and Isife, 2010; Chukwuemeka et al., 2018). In an attempt to prevent herders-farmers' conflicts, the Bayelsa state government recently outlaws herd mobility (Premium Times, 2021). This move increases the cost of cattle products with a not much decline in herd mobility. Regardless, a network of strips and pipeline right-of-way (PROW) bestrides a substantial portion of Bayelsa land mass. PROW are legally authorized pipeline corridors across land or water that enable the construction, operation, and maintenance of pipelines used for transporting resources like oil and natural gas across vast distances (Brogan et al., 2023; Graft and Welreven, 2024). The existence of PROW results from a legal right and agreement to a compensation amount between landowners, pipeline operators, and the government to permit the setting of easements (Oyinloye et al., 2017). The grant of easement allows the use of land as a permanent right-of-way (ROW), typically 50 feet wide but may be wider depending on specific locations (Thome, 2017). Generally, the majority of pipelines installed on ROW in Bayelsa State are buried, and managing vegetation within the linear corridor presents both challenges and opportunities. Leveraging on the challenges of clearing the grasses by simultaneously using the space for livestock grazing can be a potential strategy for integrated vegetation management and a way to forestall a wide range of interactions between herders and farmers.

Although the ROW agreement spells out the land use restrictions for property owners, because the pipeline is buried, normal gardening and agricultural activities are generally acceptable, though subject to some limitations considering that they are not threatening to the easement (Landowner's Guide, 2016; Thome, 2017), while aerial surveillance and routine maintenance access are easily executed. As trend in rangelands worldwide indicate a shift toward management for biodiversity conservation rather than solely for livestock production, the potential for utilizing right-of-way areas for grazing merits examination. Right-of-way areas like pipeline corridors could offer an alternative grazing resource, potentially reducing farmer-herder conflicts, the pressure on primary rangelands, and enabling more comprehensive conservation efforts (Bohnert and Stephenson, 2016). However, understanding the composition, prevalence, and palatability of the grasses within the strip is a crucial first step in evaluating its suitability for cattle grazing, while tailored strategies could subsequently be developed by the land manager.

However, this study investigates grass diversity and distribution pattern along a pipeline linear corridor in two local government areas in Bayelsa State and the feasibility of utilizing them for cattle grazing

Method

The Study Area

The study was carried out on pipeline right of way in two Local Government Areas (LGAs), Yenagoa and Ogbia. The areas lie within coordinates 4º15'N and 5º23'N, and 5º22'E and 6º45'E. The vegetation of the area is tropical and boasts the highest rainfall (2000 mm and 4500 mm annually) in Nigeria and one of the most extensive wetland areas in Africa. Bayelsa State has one of the largest crude oil and natural gas deposits in Nigeria, and industrial activities revolve mostly around the oil and gas sub-sector.

Map of the Study Area

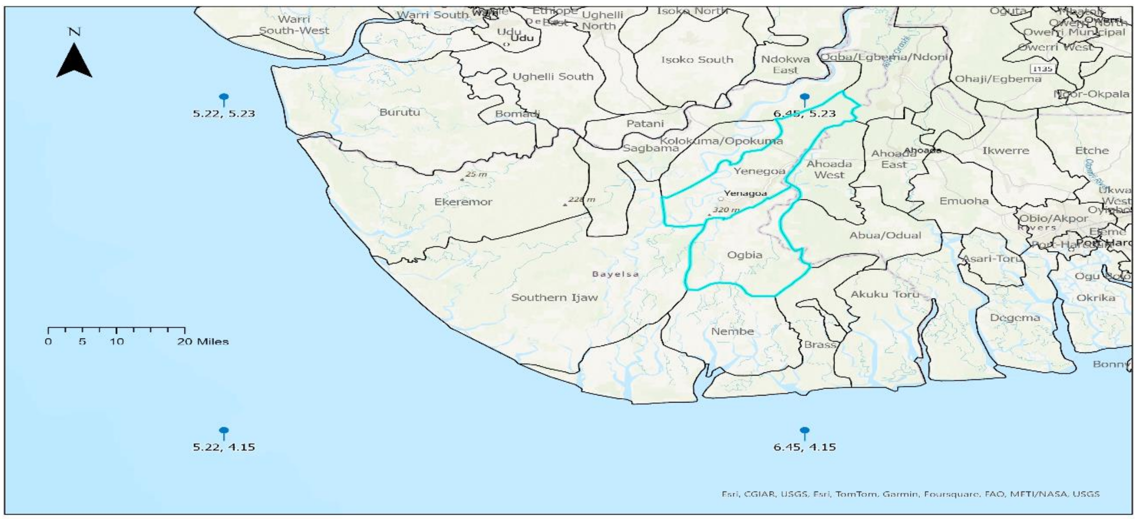

Fig 1. A Map showing Pipeline right of way in Yenogoa and Ogbia Local Government Area

Field sampling design, data collection, and species identification

The simple random sampling methods involving the random pair technique procedures of Nkoa et al. (2015) and Olayinka et al. (2020) were used. Three sampling plots, each measuring 50 m by 100 m at 300 m equi-distance apart, were mapped out along the Pipeline ROW corridor in Yenagoa LGA as well as in Ogbia LGA. A total of 60 (1.5 m by 1.5 m quadrats) were used in each of the LGAs, 20 per plot laid in random pairs, 0.5 m away from the edges of the strip to minimize the edge effect. Subsequently, the number of individuals of each species within each quadrat was identified, enumerated, and recorded. Species were identified at the family and species level, while the number of tillers per grass species within each 1.5 m2 quadrat was counted, and the total number of the species at the LGA level was recorded. Identification of the species was done at the sites, and voucher specimens of those that could not be identified immediately were collected and sent to the herbarium unit of Ekiti State University for proper identification. Literature-reported guidelines of Keay et al. (1964), Gill (1992), Hutchinson and Dalziel (2014) were used, as well as florae of the region, including those of Nyananyo (2006) and Aigbokhan (2014). All the plants encountered were identified to species level. Besides, the growth habits of the species were also documented.

Moreover, taxonomic data of the species obtained were used to determine the diversity indices (Simpson index (D), Shannon-Wiener index of diversity (H), Pileou's index of evenness (E), and the Margalef index (d)), as well as the frequency and density of the species.

Pi is the proportion of individuals of the *i*th species. Where Pi = n*i*/N, ni = number of individuals of the ith species in the plot, N = total number of individuals in the plot, and S = number of species in the plot. The value of 'D' ranges between 0 and 1, where 1 represents infinite diversity and 0, no diversity.

Shannon-Wiener index (H) = -Pi = $\sum$(logPi)

Where Pi is the same as Simpson's index.

Pileou's index of evenness (E) = H/M_{max} = H/logS

Where H = Shannon Wiener index and S = total number of species recorded. Evenness assumes a value between 0 and 1, with 1 being complete evenness.

Margalef's index (D) = S-1/logN.

Where S = total number of species and N = total number of individuals in the plot used to calculate species richness.

Results

Table 1 reveals the species, diversity, and frequency index of the grasses across the two sampling sites. The highest density in Ogbia was observed for *P. laxum* (7.93 m2), followed by *A. zizanioides* (6.99m^2) and *S. africana* (5.82m^2). While in Yenagoa, *L. haxandra* yielded the highest mean density of 9.42m^2, followed by *P. subalbidum* 8.28m^2 and *Cyperus* species (6.44

m2). The highest frequency index (70%) recorded in Ogbia PROW occurred in *A. compressus, O. longistamiinata, and A. gangetica.* Whereas, *A. compressus* also constituted the highest frequency index (75%) in Yenagoa PROW, followed by *O. corymbosa* and *P. maximum* (70%) each. Nineteen families were represented in four different growth habits (Fig. 1). The most often encountered families were Poaceae (31), Cyperacaee (9) and Asteraceae (6); others were valued in parenthesis. A total of 67 species were accessed in Ogbia site and 66 species in Yenagoa. Poaceae and Cyperaceae account for two-thirds of the entire species recorded and were the commonly occurring grasses by growth habits. Herbs ranked second, the majority of which were Asteraceae; other growth habits observed are vine and fern. Vine was rare in occurrence, whereas fern clumped in its distribution pattern.

The biodiversity indices calculated for the grass species in the two sampling points are presented in Table 2. The Simpson index values (0.023 and 0.026) and the Shannon-Wiener index values (3.953 and 3.346) recorded in Ogbia and Yenagoa sites, respectively, suggest high species diversity and that no species has an absolute relative abundance, indicating a more balanced community. The evenness index values (0.003 and 0.003) suggested that the site's grass structure was predominantly composed of a few dominant species. Margalef values (of 7.449 and 7.329) indicate that the two study sites have equally high levels of species richness, highlighting their potential as diverse grazing resources in these areas. Generally, the indices reveal that the two communities were complex, with a likelihood that many of the species interactions contribute to the ecosystem dynamic. Sixty-six of the species had a 99% occurrence on both sites, while eighteen had a ≥50% frequency index in Ogbia PROW study plot. And twenty-eight species had a ≥50% frequency of occurrence in Yenagoa PROW sites. It was also observed that all species were present in the sites year-round.

Table 1: Showing the Species, Density and Frequency index of the species in the two sampling sites along the PROW linear corridor

S/N	Species	Family	Sampling Points					
			Ogbia PROW			Yenagoa PROW		
			Individual species	Density (m^2)	Freq (%)	Individual species	Density (m^2)	Freq (%)
1	*Achyranthes aspera*	Amaranthaceae	99	2.2	40	113	2.51	30
2	*Acroceras zizanioides*	Poaceae	312	6.99	45	241	5.35	65
3	*Ageratum conyzoides*	Asteraceea	163	3.62	55	92	2.04	60
4	*Amaranthus spinosus*	Amaranthaceae	62	1.37	50	32	0.71	55
7	*Andropogon tectorum*	Poaceae	119	2.64	30	92	2.04	40
5	*Anthephora ampullacea*	Poaceae	59	1.31	30	33	0.73	50
8	*Aspilia africana*	Asteraceae	162	3.6	45	132	2.93	50
9	*Asystasia gangetica*	Acanthaceeae	192	4.26	70	206	4.57	60
54	*Axonopus compresus*	Poaceae	106	2.35	70	143	3.17	75
10	*Bidens pilosa*	Asteraceae	98	2.17	65	0	0	0
11	*Brachiaria deflexa*	Poaceae	194	4.31	40	203	4.51	65
12	*Brachiaria falcifera*	Poaceae	89	1.97	60	62	1.37	45
30	*Brachiaria lata*	Poaceae	41	0.91	55	20	0.44	15
19	*Chloris pilosa*	Poaceae	72	1.6	50	29	0.64	45
13	*Chromolaena odorata*	asteraceae	164	3.64	35	196	4.35	55
42	*Chrysopogon acuculatus*	Poaceae	83	1.84	40	25	0.55	45
14	*Cleome viscosa*	Cleomaceae	211	4.68	20	50	1.11	35
15	*Commelina sp.*	Commelinacea	69	1.53	25	179	3.97	50

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16	*Costus sp*	costaceae	72	1.6	60	31	0.68	55
1	*Cymbopogon giganteus*	Poaceae	27	0.6	30	30	0.66	40
17	*Cyperus sp.*	Cyperaceae	243	5.4	55	290	6.44	25
18	*Digitaria horizontalis*	Poaceae	202	4.48	30	154	3.42	50
64	*Digitaria horizontalis*	Poaceae	8	0.17	25	19	0.42	50
21	*Echinochloa sp.*	Poaceae	91	2.02	30	148	3.28	55
20	*Echinochloa stabnina*	Poaceae	42	0.93	15	59	1.31	55
22	*Eclipta alba*	Asteraceae	82	1.82	20	57	1.26	5
23	*Eleusine indica*	Poaceae	201	4.46	20	148	3.28	55
33	*Elytrophorus spicatus*	Poaceae	27	0.6	25	12	0.26	45
24	*Eragrostis tenella*	Poaceae	68	1.51	35	45	1	25
60	*Launaea taraxacifolia*	Asteraceae	7	0.15	40	12	0.26	25
26	*Fimbristylis ferruginea*	Cyperaceae	43	0.95	30	30	0.66	25
25	*Fimbristylis littoralis*	Cyperaceae	94	2.08	65	79	1.75	50
28	*Fuirena ciliaris*	Cyperaceae	83	1.84	45	43	0.95	50
27	*Fuirena umbellate*	Cyperaceae	77	1.71	40	49	1.08	35
29	*Hyptis suaveolens*	Lamiaceae	19	0.42	25	9	0.2	45
31	*Ipomoea aquatic*	Convolvulacea e	57	1.26	45	19	0.42	25
32	*Ischaemum rugosum*	Poaceae	134	2.97	50	98	2.17	60
34	*Kyllinga sp.*	Cyperaceae	64	1.42	45	92	2.04	50

35	*Larportea aestuans*	Urticaceae	72	1.6	45	19	0.42	20
36	*Leersia hexandra*	Poaceae	132	2.93	50	442	9.42	10
37	*Leptochloa caerulescens*	Poaceae	101	2.24	20	163	3.62	25
56	*Leptochloa filiformis*	Poaceae	125	2.77	30	90	2	15
38	*Ludwigia sp.*	Onagraceae	21	0.56	35	43	0.95	25
39	*Luffa cylindrical*	Cucurbitaceae	20	0.44	45	41	0.91	30
40	*Mimosa invisa*	Leguminosae	143	3.17	30	199	4.42	20
41	*Mimosa pudica*	Leguminosae	101	2.27	25	162	3.6	25
43	*Momordica charantia*	Cucurbitaceae	14	0.31	25	23	0.51	45
44	*Nephrolepis biserrata*	Oleandraceae	125	2.77	35	198	4.4	55
45	*Oldenlandia corymbosaa*	Rubiaceae	54	1.2	60	32	0.71	70
46	*Oryza barthii*	Poaceae	82	1.82	40	177	3.93	40
53	*Oryza longistaminata*	Poaceae	121	2.68	70	92	2.04	50
58	*Panicum laxum*	Poaceae	357	7.93	50	173	3.84	65
48	*Panicum naximum*	poaceae	245	5.44	60	192	4.26	70
49	*Panicum subalbidum*	Poaceae	211	4.68	50	373	8.28	50
50	*Paspalum scrobiculatum*	Poaceae	143	3.17	45	217	4.82	10
51	*Pennisetum purpureum*	Poaceae	193	3.28	35	229	5.08	20
52	*Pentodon pentandrus*	Rubiaceae	122	2.71	35	142	3.15	25
66	*Perotis indica*	Poaceae	52	1.15	25	32	0.71	60
55	*Pistia stratiotes*	Araceae	14	0.31	30	43	0.95	50
57	*Rhynchospora*	Cyperaceae	42	0.93	10	52	1.15	15

	corymbosa							
3	*Sacciolepis african*	Poaceae	262	5.82	25	199	4.42	15
61	*Schoenoplectus senegalensis*	Cyperaceae	15	0.33	20	42	0.93	5
59	*Scleria sp.*	Cyperaecea	132	2.93	15	153	3.4	15
63	*Solanum torvum*	Solanaceae	9	0.2	20	3	0.06	30
65	*Spigetia anthelmia*	Loganiaceae	79	1.75	40	102	2.26	25
67	*Tridax procumbens*	Asteraceae	103	2.28	25	146	3.24	20
62	*Vossia cuspidata*	Poaceae	24	0.53	35	49	1.08	40

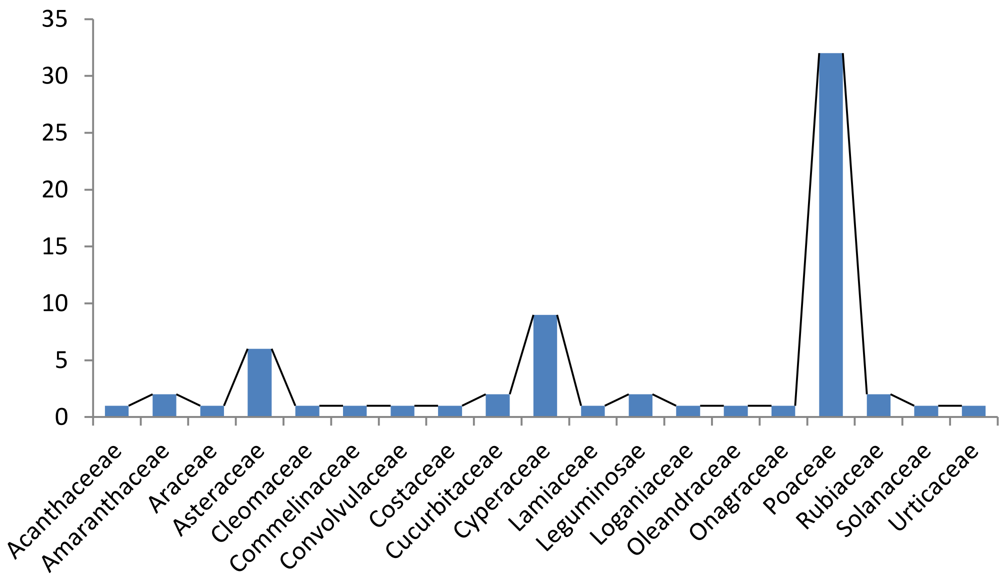

Fig 2: Showing the families' status of species in the sampling plots

Table 2: Biodiversity Indices of Grass in the two Sampling Points		
Index	**Ogbia PROW**	**Yenagoa PROW**
Simpson (D)	0.023	0.026
Shannon-Wiener (H)	3.953	3.346

Evenness (E)	0.003	0.003
Margalef (D)	7.449	7.329
Individual Sp.	7050	7100
No of Species	67	66
Grass	41	41
Herb	23	22
Fern	1	1
Vine	2	2

Discussion

This study assessed the grass composition and distribution patterns along pipeline right-of-ways and its potential use for grazing in Bayelsa State, revealing crucial insights into the ecological dynamics of the corridor. The findings demonstrate that the ROW supports a large, diverse assemblage of species; they also show signs of dominance by a few families, which can influence the overall health and functionality of the community. The high density of certain species, such as *L. haxandra*, *P. subalbidum*, *P. laxum, A. zizanioides*, and *S. africana*, indicates their adaptability to conditions typical of the pipeline corridors, and their consistency with seasons may be soil moisture content-related, which according to Mercado and Lipitan (2018) influence plant species composition and density. It can also be inferred that the grasses would not only provide food for grazing livestock but also contribute to soil stabilization and erosion control (Zhu et al., 2021), which are particularly important in highly saturated environments like Bayelsa State. The high variety of grass species emphasized by the indices values inferred that such swards could reduce reliance on a single forage source while increasing ecosystem stability and productivity (Pokorny et al., 2004). Such herbage can be beneficial to cattle as it provides a greater variety of essential vitamins, minerals, and nutrients (Boval and Dixon, 2012), with a notable impact on animal productivity and healthy growth (Zonon et al., 2022), than grasslands, which in time support only a handful of species.

Many of the species enumerated in the study sites have been reported as palatable and nutritive. A previous study of Oyedele and Akinlade (2017) affirmed that Nigerian cattle prefer grasses such as *Ageratum conyzoides* and *Bidens pilosa* with low fiber content (<30%) and high digestibility (>50%). Similarly, Adedeji and Oyawoye (2019) and Ogunmodede and Oluwafemi (2020). Averred *Launaea taraxacifolia,* one of the species encountered in the study plots, as high in volatile organic compounds attractive to cattle. Besides, *Tridax procumbens,* a member of Asteraceae, was emphasized in Ologunagba and Oluwafemi (2018) as high in crude protein content (>15%) and suitable for cattle grazing. Adedeji and Oyawoye (2019) also articulated the high energy content (>2.5 Mcal/kg) of *Chromolaena odorata* and *Imperata cylindrical,* positing those as suitable for livestock production.

The valuation from ecological gauges like species density, growth habits, and frequency of occurrence further stresses the heterogeneity of the area, of which Primm (1991) averred could offer a boost to immunity and reduce susceptibility in pasturage, considering that such a community could maintain ecological balance and harbor a wide array of insects and other organisms that may serve as natural pest control (Alabi and Ogunsanwo, 2017). The ecological implications of this study extend beyond understanding species composition. The identification of species that thrive in the ROW offers valuable data for its potential use for cattle grazing and sustainable land management strategies. Moreover, the findings highlight the potential for integrating grazing management within industrial landscapes, PROW. Given the role of cattle as an important source of protein in Bayelsa State, optimizing the use of grass along PROWs could enhance food security while minimizing conflicts between herders and farmers in the linear corridor. This integration can lead to more sustainable land-use practices that balance economic development with ecological preservation, addressing the challenges of herder-farmer conflicts, cattle production, and land degradation.

conclusion :

In conclusion, this study underscores the importance of pipeline right-of-ways as habitats for diverse grass species in Bayelsa State. The findings provide a foundation for future research aimed at exploring the proximate and mineral composition of the dominant species. Continuous monitoring and management will be crucial to enhance grass diversity and maintain the ecological functions of this environment, ultimately supporting sustainable development of cattle production in the corridor.

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