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Diversity and biomass production of fertilizer-stimulated pasture riparian wetland ecosystem in the dry season

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ABSTRACT: The swamp ecosystem has long been home to buffalo, cows, and other animals. Swamp conservation and restoration projects are crucial to preserving plant diversity and guaranteeing the food supply. Thus, this study aimed to evaluate the potential of inorganic fertilizers to promote plant diversity and to observe the revegetation of animal waste-derived plant diversity in the swamp during the dry season. The study was conducted from August 2021 to July 2022 in Rambutan Village (-3.123910, 104.937812), Indonesia. The stimulants used in this research were buffalo manure, NPK fertilizer and Urea fertilizer. The stimulant solution was once uniformly applied to the plots during the dry season. Soil pH for all plots was comparatively constant (4-6) during the research, while water pH varied from 3.7 to 6.5, and water level was 0-83 cm over 8 months. It was found that plots stimulated with manure, NPK, and urea fertilizer resulted in 13, 6, and 3 species, respectively. *Hymenachne amplexicaulis*, *Cyperus digitatus*, and *Sacciolepis interrupta* had the highest SDR values among the species identified in all plots. The yearly biomass generated by manure, NPK and Urea was 8.97 kg/m², 3.01 kg/m², and 2.08 kg/m², respectively. Stimulants derived from buffalo manure promote faster growth and greater diversity.
Keywords: native forage grasses; inland marsh; wetlands; extensive livestock farming.

Diversidade e produção de biomassa de pastagens estimuladas por fertilizante ecossistema de zonas úmidas ribeirinhas na estação seca

RESUMO: O ecossistema do pântano há muito que serve de lar para búfalos, vacas e outros animais do pântano. Para preservar a diversidade vegetal e garantir o fornecimento de rações, os projetos de conservação e restauro de zonas úmidas são cruciais. O estudo foi realizado de agosto de 2021 a julho de 2022 na aldeia de Rambutan (-3.123910, 104.937812), Indonésia. Os estimulantes utilizados nesta investigação foram o estrume de búfala, o fertilizante NPK e a Ureia. Durante a estação seca, a solução estimulante foi aplicada uniformemente nas parcelas. O pH do solo para todas as parcelas foi comparativamente constante (4-6) durante o levantamento, enquanto o pH da água variou de 3,7-6,5 e o nível da água de 0-83 cm ao longo de 8 meses. Verificou-se que as parcelas estimuladas com estrume, NPK e adubo de ureia resultaram em 13, 6 e 3 espécies, respectivamente. *Hymenachne amplexicaulism, Cyperus digitatus* e *Sacciolepis interrupta* apresentaram os valores mais elevados de SDR entre as espécies identificadas em todas as parcelas. A biomassa anual gerada pelo estrume, NPK e Ureia foi de 8,97 kg/m², 3,01 kg/m² e 2,08 kg/m², respectivamente. Os estimulantes derivados do estrume de búfalo promovem um crescimento mais rápido e uma maior diversidade.
Palavras-chave: ervas forrageiras nativas; pântano interior; áreas únidas; pecuária extensiva.

1. INTRODUCTION

Wetlands known as swamps provide a special kind of agroecosystem when water from rivers or lakes overflows, either occasionally or continually, for three to six months out of the year, at a depth that ranges from 50 to more than 150 cm (ALWI; TAPAKRISNANTO, 2017). The water levels fluctuate according to the seasons, becoming progressively lower during the dry season and higher or even flooded during the rainy season.

Since large-scale plantations developed, swamps have undergone hydrological changes that have altered the pattern of height and duration of water inundation (MA et al., 2019). The types and growth of different plants are greatly influenced by the flooding and drying of water in swamp areas; a limited variety of plants were found in the dry season (AFRIANI et al., 2023). The changes of flooding duration from up to six months to only one month in the swamp area during the rainy season have resulted in the dominance of *Imperata cylindrica* (IKHSAN et al., 2020). The long dry season is also a factor causing few plants and grass to be able to live in swamp areas.

Naturally, plant species in swamps remain unchanged year after year. Swamp environments are home to swamp buffalo and other cattle because they are abundant with grass species like *Digitaria* sp. and *Alternanthera* sp. (NAEMAH et al., 2020). The type and quality of forage grass greatly influence livestock feed (QUINTERO-ANZUETA et al., 2021). Thus, the swamp ecosystem becomes a contributor and supplier of feed for buffalo.

The length and depth of flooding are affected by changes in land use and climatic change, affecting plant community species' dominance (ARDIANSYAH et al., 2021; GARSSEN et al., 2015). Important species in the ecology of forage grasslands are declining in line with the shift in species dominance (BARBOSA DA SILVA et al., 2016). For this reason, maintaining plant diversity and guaranteeing feed depend heavily on conserving and rehabilitating the swamp area. Replanting native flora and managing swamp land sustainably are two initiatives (Badan Penelitian dan Pengembangan Pertanian, 2014). For swamp vegetation to continue providing animal feed, technological intervention is required. There has been research on regrowing native species in swamp areas (LAMPELA et al., 2017; WAHYUDI; TRIYADI, 2019; WIBISONO; DOHONG, 2017). There's no special method for cultivating native grass in South Sumatra's swamp areas.

Theoretically, the types and population of grass can be increased by incorporating organic material from animal manure into plant cultivation (LITTLE et al., 2015). Based on this concept, adding fertilizer from buffalo dung in swamp land can regrow plants in the swamp. In addition, the condition of the swamp land, which is poor in nutrients and dry during the dry season, is thought to be the cause of the limited ability of grass to grow (FILHO et al., 2020; MUHAKKA et al., 2020). Through the addition of inorganic fertilizer, it is thought to be able to stimulate the growth of natural plants and grass that already exist there (SHI et al., 2024).

For this reason, knowledge on the potential of inorganic fertilizers to promote plant diversity and information on the revegetation of animal waste-derived plant diversity are essential for reforestation in wetland areas during the dry season.

2. MATERIAL AND METHODS

2.1. Study Area

The study was conducted in Rambutan Village (-3.123910, 104.937812), Banyuasin Regency, South Sumatra Province, Indonesia, from August 2021 to July 2022. The study area was a buffalo pasture wetland environment on a shallow swampland. The sample plots were positioned roughly 10 meters apart, in parallel positions, and about 100 meters from the swamp's edge. The plot size was 4 x 4 meters and surrounded by 1.2-meter-tall wooden fences.

2.2. Fertilizer stimulant application

Inorganic (NPK and urea fertilizers) and organic (fertilizer made from buffalo manure) were applied as the treatment. The dosages of each treatment plot consisted of 12 kg of buffalo manure (10 tons/ha), 2.4 kg of NPK (200 kg NPK/ha), and 2.4 kg of urea (200 kg Urea/ha). Each treatment substance was then diluted into 50 liters of water. The stimulant application was carried out in the afternoon by equally scattering them on the soil surface. All treatment plots were also left unwatered and without any additional fertilizers given. Three different plots were identified by different names: the Manure Plot, NPK Plot, and Urea Plot.

2.3. Soil, waterlogging and agroclimate observations

A digital soil pH meter of Hanna H199121 was used to monitor soil pH before stimulant application on each plot. Swamp water pH was also measured with a digital pH meter of AMTAST KL6022. Water level was also measured directly in the plots. The measurements were made on the plot every month. The Meteorology, Climatology, and Geophysics Agency provided data on regional rainfall and wet days.

2.4. Data Analysis

The data were analyzed using the Student's t-test, and the results were presented in tabulation and histogram form. The measurement of grass coverage percentage was carried out 2 and 6 weeks after application. Plant stems or clumps were cut approximately 5 cm above the ground and weighed using a scale to collect data of each type of plant from each plot. The samplings were carried out three times: in November 2021, March 2022, and July 2022.

Direct observations to identify the existing plant species and families were made based on Plants of the World Online (POWO, 2024). From each plot, the biomass was collected and sorted by type of plant. To obtain the Summed Dominance Ratio (SDR) value, the frequency and dominance of plants were determined for each plot (AMARULLAH et al., 2017). The SDR value indicates the role level of the species in the sample plot, which is a relative comparison of the weed type's Importance Value Index (IVI) value. The stronger the role in the plant community, the higher the SDR value ranges from 1 to 100%.

$$\text{Species Frequency (F)} = \frac{\text{Number of plots where species found}}{\text{Total number of plots}}$$

$$\text{Species Dominancy (D)} = \frac{\text{The coverage area of the species found}}{\text{Total plots area}}$$

Relative Frequency (RF) or Relative Dominancy (RD)

$$= \frac{\text{F or D}}{\text{Total of F or D from all species}} \times 100\%$$

$$\text{Important Value Index (IVI)} = \text{RF} + \text{RD}$$

$$\text{Summed Dominance Ratio (SDR)} = \frac{\text{IVI}}{\text{Number of relative variables}}$$

3. RESULTS

3.1. Agroclimate, soil pH, and waterlogging in swamp pasture land

The study's initial four months of rainfall data indicated that the amount of precipitation was still low, at less than 100 mm/month. However, from August 2021 to July 2022, the amount of precipitation was already classed as high and was accompanied by a high number of wet days (Table 1).

One month after the treatment was applied, swamp land inundation started due to heavy rainfall in the swamp location and an increase in the Komering River's water level. Early in September, the swamp land's water level started to rise. It continued to rise until it reached the first and second peaks of the inundation in December 2021 and March 2022, respectively, at 60 and 82 cm, respectively. After that, the inundation in the lowland swamp land gradually decreased (Figure 1).

Swamp water pH levels appear to follow a pattern of high inundation: all treatment plots have higher pH levels in response to increased water inundation. The water pH peaked at 6.5 when the water inundation reached 70 cm, which occurred in February 2022, regardless of the high inundation, which was less than 10 cm (Figure 2).

All treatment plots had a rise in soil pH correlated with an increase in water pH, and all treatment plots saw a gradual reduction in soil pH correlated with a decline in swamp water level (Figure 3).

Tabela 1. Precipitation and number of wet days at the research location for one year.
Tabela 1. Precipitação e número de dias chuvosos no local da pesquisa durante um ano.

Month	Year	Precipitation (mm)	Wet days (days)
August		0	2
September		15	3
October	2021	76	5
November		68	9
December		242	27
Total 2021		401	46
January		114	25
February		298	22
March		367	18
April	2022	396	24
May		264	20
June		133	19
July		17	16
Total 2022		1589	144
Yearly total		1990	190

Source: Indonesian Meteorological, Climatological and Geophysical Agency (Analyzed data).
Fonte: Agência Meteorológica, Climatológica e Geofísica da Indonésia (Dados analisados).

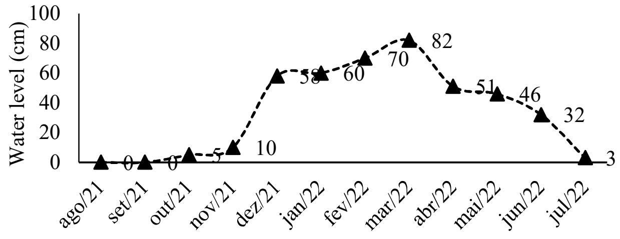

Figure 1. Monthly swamp water level during research periods.
Figura 1. Nível mensal de água do pântano durante os períodos de pesquisa.

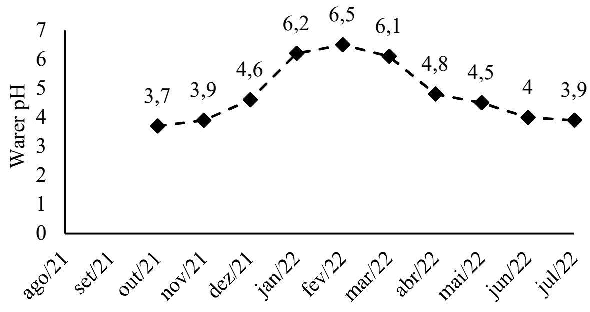

Figure 2. Monthly swamp water pH.
Figura 2. pH mensal da água do pântano.

3.2. Grass coverage area under various treatments

It appears that the growth of different grasses was encouraged more in the first two weeks following the application of buffalo manure than in the plots treated with NPK and urea fertilizers. The surface area of the grass-covered field was approximately 1.5 m²/12 m² when manure was applied. Still, after six weeks of application, it increased to 6.5 m²/12 m², making it wider than the plots treated with NPK and urea fertilizers (Figure 4).

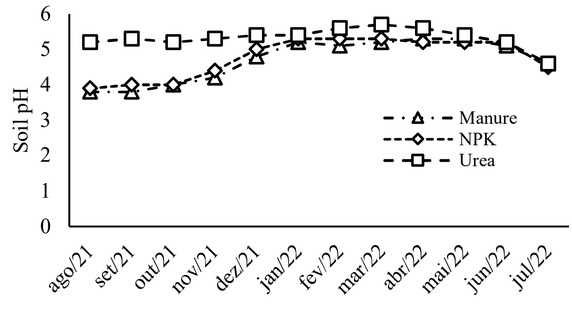

Figure 3. Monthly soil pH.
Figura 3. pH mensal do solo.

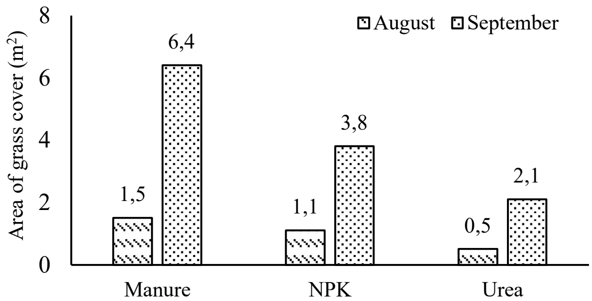

Figure 4. The land surface area covered with grass from each treatment plot in the swampland.
Figura 4. Superfície de terra coberta com grama em cada parcela de tratamento no pântano.

3.3. Type of grass from each harvest for each treatment

Two species of grass, *Hymenachne acutigluma* and *Digitaria* sp., were found in the manure sampling plot; these same species were also present in the NPK-treated plot (Table 2).

Tabela 2. Types of plants from each plot that grew on the land before waterlogging.
Tabela 2. Tipos de plantas de cada parcela que cresciam na terra antes do alagamento.

No	Manure	NPK	Urea
1	*Digitaria ciliaris*	*Digitaria longiflora*	*Cynodon dactylon*
2	*Hymenachne acutigluma*		

When forage grass was harvested thrice a year, every four months, the growing kinds varied. With a water level of 82 cm, the manure plot had the highest number of grass species, up to 9, during the second harvest. In the NPK and urea fertilizer treatments, the *Cyperus difformis* species emerged when the water level shrank to just 3 cm during the third harvest (Table 3).

There is a comparatively greater diversity of plant types (13 species) in the buffalo manure treatment's range (Table 4). Buffaloes graze extensively in the grasslands, and their diet of seeds provides a source of diversification. In some plots, chemical fertilization supports only three to six species. All plots contain the following species: *Sacciolepis interrupta*, which has low dominance, followed by *Cyperus digitatus* and *Hymenachne amplexicaulis*, both of which have high dominance. A complete list of grass types collected is given in Table 5.

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Tabela 3. Plant species and water level based on harvest time.
Tabela 3. Espécies de plantas e nível de água em função da época de colheita.

Harvest time	Treatment Plots			Water level (cm)
	Manure	NPK	Urea	
Harvest-1 (November 2021)	*Digitaria ciliaris; Alternanthera philoxeroides; Hymenachne acutigluma*	*Digitaria longiflora; Hymenachne acutigluma*	*Saciolepis interupta; Cynodon dactylon*	10
Total	3	2	2	
Harvest-2 (March 2022)	*Digitaria ciliaris; Heliotropium indicum; Cyperus digitatus; Cynodon dactylon; Digitaria ciliaris; Echinocloa colona; Hymenachne amplexicaulis; Leersia hexandra; Saciolepis interrupta*	*Hymenachne acutigluma; Saciolepis interupta*	*Saciolepis interupta; Cynodon dactylon*	82
Total	9	2	2	
Harvest-3 (July 2022)	*Leersia hexandra; Saciolepis interrupta; Ludwigia octovalvis; Ludwigia adscendens; Oxalis barrelieri; Hedyotis corymbosa*	*Hymenachne acutigluma; Alternanthera philoxeroides; Hedyotis corymbosa; Cyperus difformis*	*Saciolepis interupta; Cynodon dactylon; Cyperus difformis*	3
Total	6	4	3	

Tabela 4. Plant species in various fertilizer treatment plots in lowland swamps.
Tabela 4. Espécies de plantas em diversas parcelas de tratamento de fertilizantes em pântanos de várzea.

No.	Species	Local name	Family	Plot		
				1	2	3
1	*Alternanthera philoxeroides*	Gulma buaya	Amaranthaceae	+	+	-
2	*Alternanthera sessilis*	Keremah	Amaranthaceae	+	-	-
3	*Heliotropium indicum*	Kumpai tikus	Boranginaceae	+	-	-
4	*Cyperus digitatus*	Rumput Musang	Cyperaceae	+	+	+
5	*Cynodon dactylon*	Rumput Bahana	Gramineae	-	-	+
6	*Digitaria ciliaris*	Rumput jari	Poaceace	+	+	-
7	*Echinocloa colona*	Rumput Tuton	Gramineae	+	-	-
8	*Hymenachne amplexicaulis*	Kumpai tembaga	Poaceace	+	+	+
9	*Leersia hexandra*	Kalamenta	Poaceace	+	-	-
10	*Sacciolepis interrupta*	Rumput wuwudan	Poaceace	+	+	+
11	*Ludwigia octovalvis*	Cacabean	Onagraceae	+	-	-
12	*Ludwigia adscendens*	Tapak doro	Onagraceae	+	-	-
13	*Oxalis barrelieri*	Calincing	Oxalidaceae	+	-	-
14	*Hedyotis corymbosa*	Rumput mutiara	Rubiaceae	+	+	-
Total species				13	6	3

Tabela 5. Dominant plants based on the Importance Value Index (IVI) and Summed Dominance Ratio (SDR) values of plants from various fertilizer treatment plots in lowland swamps.
Tabela 5. Plantas dominantes com base nos valores do Índice de Valor de Importância (IVI) e da Razão de Dominância Somada (SDR) de plantas de várias parcelas de tratamento de fertilizantes em pântanos de terras baixas.

No	Species	Manure		NPK		Urea	
		IVI	SDR	IVI	SDR	IVI	SDR
1	*Alternanthera philoxeroides*	11.46	5.73	15.31	7.65	-	-
2	*Alternanthera sessilis*	7.67	3.83	-	-	-	-
3	*Heliotropium indicum*	9.38	4.69	-	-	-	-
4	*Cyperus digitatus*	14.93	7.47	32.30	16.15	51.70	25.85
5	*Cynodon dactylon*	-	-	-	-	30.29	15.14
6	*Digitaria ciliaris*	26.74	13.37	35.39	17.70	-	-
7	*Echinocloa colona*	8.33	4.17	-	-	-	-
8	*Hymenachne amplexicaulis*	62.46	31.23	69.80	34.90	82.81	41.40
9	*Leersia hexandra*	9.03	4.51	-	-	-	-
10	*Sacciolepis interrupta*	13.54	6.77	30.62	15.31	35.20	17.60
11	*Ludwigia octovalvis*	8.33	4.17	-	-	-	-
12	*Ludwigia adscendens*	8.06	4.03	-	-	-	-
13	*Oxalis barrelieri*	7.67	3.83	-	-	-	-
14	*Hedyotis corymbosa*	12.42	6.21	16.57	8.29	-	-

3.4. Biomass of forage grass in the Lebak swamp land

The t-test showed that all comparisons between fertilizer treatments were significantly different. NPK fertilizer and urea fertilizer did not differ significantly at the time of the first harvest, but they did at the second and third harvests (Table 6).

Tabela 6. Fresh biomass weight of various fertilizer treatments based on t-test.
Tabela 6. Peso de biomassa fresca de vários tratamentos de fertilizantes com base no teste t.

Harvest time \ Plot	Manure	NPK	Urea
Harvest-1			
Manure	-	5.37E-03*	6.7E-03*
NPK	-	-	5.45E-03[ns]
Urea	-	-	-
Harvest-2			
Manure	-	8.66E-05*	6,.7E-04*
NPK	-	-	1.48E-03*
Urea	-	-	-
Harvest-3			
Manure	-	7.11E-03*	5.34E-03*
NPK	-	-	1.71E-02*
Urea	-	-	-

Note: * = Significant (P(T<=t) two-tail<0.05); ns = Non-significant (P(T<=t) two-tail>0.05).
Nota: * = Significativo (P(T<=t) bicaudal<0,05); ns = Não significativo (P(T<=t) bicaudal>0,05)

With the highest findings reaching 4.59 kg/m², the grass harvest demonstrated that manure significantly impacted biomass in the swamp's grazing fields. Based on the number of species found, the manure treatment had more potential for species with high tolerance and competitive ability. Given the comparatively smaller species diversity factor, the urea fertilizer treatment produced the lowest results with only 1.01 kg/m². Grass biomass from several fertilizer treatment plots in the lowland swamp is given in Figure 5.

	Harvest 1	Harvest 2	Harvest 3
Manure	1,18	4,59	3,20
NPK	0,38	1,63	0,99
Urea	0,37	1,01	0,71

Figure 5. Grass biomass from several fertilizer treatment plots in lowland swamps.
Figura 5. Biomassa de gramíneas de diversas parcelas de tratamento de fertilizantes em pântanos de terras baixas.

4. DISCUSSION

The high-water levels significantly impacted soil pH in each treatment plot. Before puddles formed, the pH of the soil was found to be influenced by various fertilizer treatments. Manure, for example, could raise the pH of the soil to 5.2, which is higher than NPK and urea fertilizers, which have a pH of less than 4. But while the water level was high, it tended to return almost exactly to the same plot and did not vary much when the water subsided, possibly due to floods rinsing the water away. Floods alter soil functions by quickly releasing nutrients, lowering soil fertility (SÁNCHEZ-RODRÍGUEZ et al., 2019).

It is believed that the stimulant manure made from buffalo manure contains a variety of plant seeds, allowing many to thrive in the first 2 weeks after application. The availability of native grass seeds is typically restricted, making it impossible for more grass growth to be stimulated by NPK and urea fertilizers.

The manure sampling plot may cover the soil surface more quickly at the beginning of the application due to differences in the types and numbers of species that grow. Before the formation of puddles, the sampling plot treated with urea fertilizer only covered 2.1 m²/12 m² until the sixth week following application. Apart from seeds preserved in the soil, feces also disperse seeds, particularly those that haven't broken down into manure for seed transmission (OVEISI et al., 2021).

Plant growth responses to hydrological circumstances vary by species. Flooding greatly enhances a species' ability to expand, but plants not adapted to high water levels will find their growth restricted. High water levels do not affect all plant communities; species composition and stem density define plant biomass. Plant biomass is also affected by other abiotic elements like temperature, soil nutrients, and light intensity. On the other hand, elevated water levels indirectly impact soil nutrients (LOU et al., 2016).

The least number of different types of grass is found in areas treated with urea fertilizer. This is believed to be because urea is applied by dissolving it in water, which produces a high concentration of ammonium that kills seed deposited on the soil's surface (SUNDARAM et al., 2019). The sprouts that grow after receiving the stimulant from Ammonium then die when exposed to the sun's heat.

Digitaria ciliaris (13.37%) and *Hymenachne amplexicaulis* (31.23%) were the most common manure treatment species. Since *Hymenachne amplexicaulis* is a semi-aquatic annual grass, it can withstand severe levels of flooding. Then, as a sort of swamp greenery, the vegetation has a comparatively high mineral content (MUHAKKA et al., 2019). The most common species in the NPK fertilizer treatment are *Hymenachne amplexicaulis* (34.90%), followed by *Hymenachne amplexicaulis* (41.40%) and *Cyperus digitatus* (25.85%) in the urea fertilizer treatment. While *Cyperus digitatus* is present in every treatment, Digitaria ciliaris is only found in the manure and NPK fertilizer treatments. Livestock use grasses and teki grasses, such as *Cyperus digitatus* and *Digitaria ciliaris*, as animal fodder, varying degrees of preference from mildly to frequently utilized (ERNAWATI; NGAWIT, 2015).

Good pastures produce feed consisting of grass (Poaceae) and legumes (Fabaceae). Legumes were not found in all fertilizer treatment plots in the lowland swamp. The proportion of forage sources and productivity as feed protein sources in both research areas was inadequate. Rainwater runoff from the river overflows affects groundwater, causing plants to have difficulty absorbing soil nutrient ions. Solid/hard and alkaline soil conditions cause very few legume plants. The lack of legume proportions in grasslands causes low forage quality, especially during the dry season (NURJAYA et al., 2023).

In swamp areas, livestock pastures are characterized by inundation for several months of the year, resulting in flooding followed by dry periods. Depending on the species ' tolerance, different biomass production is caused by flood patterns, such as the depth and duration of inundation (DAI et al., 2020). Furthermore, competition plays a significant role in determining this region's plant distribution and community structure. As Zhang et al. (2014) stated, specific species' existence is reliant. Due to more competition, legumes comprise a smaller percentage of grazing pastures than weeds and Gramineae.

Fertilization treatment for pastures aims to supply nutrients; nevertheless, it is important to consider the type, requirements, methods, and application timing. Additionally, it is crucial to examine the impact of soil and plant characteristics (MARTA, 2016).

Despite the same comparison across treatments, the third harvest was marginally lower because the prior harvest still impacted it. LAN et al. (2021) state that flooding's impact on wetland plant biomass depends on the season, soil nutrient availability, and inundation period. The period of flooding has a quadratic relation with the total soil N content, total P content, and N:P ratio, peaking at about 220 days. So, there is still potential for a further increase of up to seven months.

A substantial amount of nutrients from sediment and river runoff support the various species that manure provides, leading to eutrophication and an increase in productive species. Species not adequately adapted will die off, and plant communities will shift toward groups with many tolerant species (GARSSEN et al., 2015). If improperly managed, it could harm the species diversity in the swamp grasslands, lowering the amount and quality of available feed. Therefore, a thorough understanding of the dynamics of water levels and species richness management is essential to optimize the potential of swamp fields as a source of forage grass. Seasons, grazing frequency, and other human activities that could impact the revegetation results should also be considered. Furthermore, long-term research may be required to evaluate the viability of revegetation techniques. The results of this study can provide valuable insights for ranchers, land managers, and policymakers in managing grasslands for sustainable forage production. It further implies the mechanisms for maintaining diversity in swamp communities.

5. CONCLUSIONS

Based on the results, it was concluded that: 1) Buffalo manure stimulant can be used for pasture revegetation activities. Particularly in plant diversity and biomass production, it outperformed urea and NPK fertilizer stimulants.

Pasture application contributed to a greater variety of species. The SDR of dominant species found in Manure, NPK and Urea fertilizer plots were *Hymenachne amplexicaulis* (31.23:34.90:41.40), *Cyperus digitatus* (7.47;16.15;25.85) and *Sacciolepis interrupta* (6.77;15.31;17.60), respectively.

There were 13 species identified in the manure treatment, 6 in the NPK fertilizer treatment, and 3 in the urea fertilizer treatment.

The inundation pattern in swamp areas provides a suitable environment for some species and limits the growth of others. Inundation during the rainy season brings high nutrient content from river runoff and sediment, increasing the abundance of productive species.

6. REFERENCES

AFRIANI, P.; JUSWARDI, J.; MARISA, H. Komposisi, keragaman dan struktur vegetasi rawa Lebak Tanjung Senai, Ogan Ilir, Sumatera Selatan. Spizaetus: **Jurnal Biologi Dan Pendidikan Biologi**, v. 4, n. 2, e168, 2023. https://doi.org/10.55241/spibio.v4i2.167

ALWI, M.; TAPAKRISNANTO, C. Potensi dan Karakteristik Lahan Rawa Lebak. In: ALWI, M.; TAPAKRISNANTO, C. (Orgs). **Karakteristik dan Pengelolaan Lahan Rawa**. IAARD Press, 2017. p. 1-21. Available at: https://repository.pertanian.go.id/handle/123456789/6628. Accessed on: 19 May. 2025.

AMARULLAH, E. T.; TRIZELIA; YAHERWANDI; HAMID, H. Diversity of plant species in paddy ecosystem in West Sumatra, Indonesia. **Biodiversitas**, v. 18, n. 3, p. 1218-1225, 2017. https://doi.org/10.13057/biodiv/d180346

ARDIANSYAH, M.; NUGRAHA, R. A.; IMAN, L. O. S.; DJATMIKO, S. D. Impact of land use and climate changes on flood inundation areas in the Lower Cimanuk Watershed, West Java Province. **Jurnal Ilmu Tanah dan Lingkungan**, v. 23, n. 2, p. 5360, 2021. https://doi.org/10.29244/jitl.23.2.53-60

Badan Penelitian dan Pengembangan Pertanian. 2014. Biodiversiti Rawa : Eksplorasi, Penelitian, dan Pelestariannya. In: **Biodiversiti Rawa : Eksplorasi, Penelitian, dan Pelestariannya**. IAARD Press, 2014. P. 1-21. Available at: https://repository.pertanian.go.id/items/e4775457-434b-4461-8dff-76cd4cd91cb7. Accessed on: 19 May. 2025.

BARBOSA DA SILVA, F. H.; ARIEIRA, J.; PAROLIN, P.; DA CUNHA, C. N.; JUNK, W. J. Shrub encroachment influences herbaceous communities in flooded grasslands of a neotropical savanna wetland. **Applied Vegetation Science**, v. 19, n. 3, p. 391-400, 2016. https://doi.org/10.1111/avsc.12230

DAI, X.; YU, Z.; YANG, G.; WAN, R. Role of flooding patterns in the biomass production of vegetation in a typical herbaceous wetland, Poyang Lake Wetland, China. **Frontiers in Plant Science**, v. 11, e521358, 2020. https://doi.org/10.3389/fpls.2020.521358

ERNAWATI, N. M. L.; NGAWIT, I. K. 2015. Eksplorasi dan identifikasi gulma, hijauan pakan dan limbah pertanian yang dimanfaatkan sebagai pakan ternak di wilayah lahan kering lombok utara. **Buletin Peternakan**, v. 39, n. 2, e92, 2015. https://doi.org/10.21059/buletinpeternak.v39i2.6713

FILHO, A. A. D. N.; COSTA, R. N. T.; SOUSA, C. H. C. D.; MATEUS, C. D. M. D.; NUNES, K. G. 2020. Effect of excess soil water on the development of Bermuda grass (*Cynodon* spp.). **Revista Brasileira de Engenharia Agrícola e Ambiental**, v. 24, n. 5, p. 298-303, 2020. https://doi.org/10.1590/1807-1929/agriambi.v24n5p298-303

GARSSEN, A. G.; BAATTRUP-PEDERSEN, A.; VOESENEK, L. A. C. J.; VERHOEVEN, J. T. A.; SOONS, M. B. Riparian plant community responses to increased flooding: A meta-analysis. **Global Change Biology**, v. 21, n. 8, p. 2881-2890, 2015. https://doi.org/10.1111/gcb.12921

IKHSAN, Z.; HIDRAYANI, H.; YAHERWANDI, Y.; HAMID, H. Keanekaragaman dan dominansi gulma pada ekosistem padi di lahan pasang surut kabupaten indragiri hilir. **Agrovigor: Jurnal Agroekoteknologi**, v. 13, n. 2, p. 117-123, 2020. https://doi.org/10.21107/agrovigor.v13i2.7463

LAMPELA, M.; JAUHIAINEN, J.; SARKKOLA, S.; VASANDER, H. Promising native tree species for reforestation of degraded tropical peatlands. **Forest Ecology and Management**, v. 394, p. 52-63, 2017. https://doi.org/10.1016/j.foreco.2016.12.004

LAN, Z.; CHEN, Y.; SHEN, R.; CAI, Y.; LUO, H.; JIN, B.; CHEN, J. 2021. Effects of flooding duration on wetland plant biomass: The importance of soil nutrients and season. **Freshwater Biology**, v. 66, n. 2, p. 211-222, 2021. https://doi.org/10.1111/fwb.13630

LITTLE, N. G.; MOHLER, C. L.; KETTERINGS, Q. M.; DITOMMASO, A. Effects of organic nutrient amendments on weed and crop growth. **Weed Science**, v. 63, n. 3, p. 710-722, 2015. https://doi.org/10.1614/ws-d-14-00151.1

LOU, Y.; PAN, Y.; GAO, C.; JIANG, M.; LU, X.; XU, Y. J. Response of plant height, species richness and aboveground biomass to flooding gradient along vegetation zones in floodplain wetlands, Northeast China. **PLoS One**, v. 11, n. 4, e0153972, 2016. https://doi.org/10.1371/journal.pone.0153972

MA, X.; LACOMBE, G.; HARRISON, R.; XU, J.; VAN NOORDWIJK, M. Expanding rubber plantations in Southern China: Evidence for hydrological impacts. **Water**, v. 11, n. 4, e651, 2019. https://doi.org/10.3390/w11040651

MARTA, Y. Manajemen Padang Penggembalaan Di Bptuhpt Padang Mengatas. **Pastura**, v. 6, n. 1, e36, 2016. https://doi.org/10.24843/pastura.2016.v06.i01.p11

MUHAKKA, M.; SUWIGNYO, R. A. Kandungan Mineral Hijauan Rumput Rawa Sebagai Pakan Kerbau Pampangan di Sumatera Selatan. In: Seminar Nasional Lahan Suboptimal, **Prosiding...** 2019. p. 92-92. Available at: http://conference.unsri.ac.id/index.php/lahansuboptimal/article/download/1250/640. Accessed on: 19 May. 2025.

MUHAKKA, M.; SUWIGNYO, R. A.; BUDIANTA, D.; YAKUP, Y. Nutritional values of swamp grasses as feed for Pampangan Buffaloes in South Sumatra, Indonesia. **Biodiversitas Journal of Biological Diversity**, v. 21, n. 3, p. 953-961, 2020. https://doi.org/10.13057/biodiv/d210314

NAEMAH, D.; RACHMAWATI, N.; PUJAWATI, E. D. Keragaman Jenis Tumbuhan Bawah Hutan Rawa Gambut Di Kabupaten Banjar. **Jurnal Hutan Tropis**, v. 8, n. 3, e298, 2020. https://doi.org/10.20527/jht.v8i3.9630

NURJAYA; SEPTIANI, T.; NURCAYA; SEMA. Produksi Hijauan dan Komposisi Botanis di Padang Penggembalaan Alam Desa Ujung Baru Kecamatan Tanasitolo Kabupaten Wajo. **Jurnal Ilmu dan Industri Peternakan**, v. 9, n. 1, p. 10-19, 2023. https://doi.org/10.24252/jiip.v9i1.31596

OVEISI, M.; OJAGHI, A.; RAHIMIAN, M. H.; MÜLLER-SCHÄRER, H.; YAZDI, R. K.; KALEIBAR, P. B.; SOLTANI, E. Potential for endozoochorous seed dispersal by sheep and goats: Risk of weed seed transport via animal faeces. **Weed Research**, v. 61, n. 1, e12461, 2021. https://doi.org/10.1111/wre.12461

POWO_Plants of the World Online. **Kew Science**. Facilitated by the Royal Botanic Gardens, Kew. 2024. Available at: https://powo.science.kew.org/

QUINTERO-ANZUETA, S.; MOLINA-BOTERO, I. C.; RAMIREZ-NAVAS, J. S.; RAO, I.; CHIRINDA, N.; BARAHONA-ROSALES, R.; MOORBY, J.; ARANGO, J. Nutritional Evaluation of Tropical Forage Grass Alone and Grass-Legume Diets to Reduce in vitro Methane Production. **Frontiers in Sustainable Food Systems**, v. 5, p. 1-13, 2021. https://doi.org/10.3389/fsufs.2021.663003

SÁNCHEZ-RODRÍGUEZ, A. R.; HILL, P. W.; CHADWICK, D. R.; JONES, D. L. Typology of extreme flood event leads to differential impacts on soil functioning. **Soil Biology and Biochemistry**, v. 129, p. 153-168, 2019. https://doi.org/10.1016/j.soilbio.2018.11.019

SHI, T. S.; COLLINS, S. L.; YU, K.; PEÑUELAS, J.; SARDANS, J.; LI, H.; YE, J. S. A global meta-analysis on the effects of organic and inorganic fertilization on grasslands and croplands. **Nature Communications**, v. 15, e3411, 2024. https://doi.org/10.1038/s41467-024-47829-w

SUNDARAM, P. K.; MANI, I.; LANDE, S. D.; PARRAY, R. A. Evaluation of urea ammonium nitrate application on the performance of wheat. **International Journal of Current Microbiology and Applied Sciences**, v. 8, n. 1, p. 1956-1963, 2019. https://doi.org/10.20546/ijcmas.2019.801.205

TRINUGROHO, M. W.; MAWARDI. 2018. Pemantauan Area Genangan Air Pada Rawa Lebak Menggunakan Teknologi Penginderaan Jauh. **Jurnal Ilmiah Geomatika**, v. 23, n. 2, e49, 2018. https://doi.org/10.24895/jig.2017.23-2.716

WAHYUDI; TRIYADI, A. Growth of Jelutung rawa (*Diera lowii*) at the Peat Swamp Land in Pulang Pisau District, Central Kalimantan. **Jurnal Hutan Tropika**, v. 14, n. 2, p. 99-107, 2019. https://e-journal.upr.ac.id/index.php/JHT/article/view/1152

WIBISONO, I. T. C.; DOHONG, A. **Panduan Teknis Revegetasi Lahan Gambut**. Badan Restorasi Gambut (BRG) Republik Indonesia, 2017. 103p. Available at: https://indonesia.wetlands.org/id/download/1383/?tmstv=1732236462

ZHANG, X. H.; MAO, R.; GONG, C.; YANG, G. S.; LU, Y. Z. Effects of hydrology and competition on plant growth in a freshwater marsh of northeast China. **Journal of Freshwater Ecology**, v. 29, n. 1, p. 117-128, 2014. https://doi.org/10.1080/02705060.2013.825821

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