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Feed Management of Balinese Cattle in Post-Mining Land

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Abstract
Reclaimed post-coal mining land holds potential for use as grazing areas and forage production. This research aimed to assess the potential and feed management strategies for Bali cattle (Bos sondaicus) on post-mining land. The study was conducted at the Pit Jupiter reclamation site of PT Kaltim Prima Coal using a combination of field observations and in-depth interviews. Vegetation sampling followed the Halls method with a 1m x 1m plate meter across 80 sampling points within a 67.28-hectare pasture divided into Pedok (site) 3 and Pedok 2. Soil samples, taken to analyze chemical properties, were collected using a random sampling method at 10 points at a depth of 0-20 cm. The potential of the pasture was evaluated based on soil fertility status, forage identification, importance value index (INP), forage production, and livestock carrying capacity. The vegetation included 32 species from 13 families, with Paitan grass (Paspalum conjugatum) being dominant, achieving the highest INP value of 95.12%. Feed management on the reclaimed land utilized an extensive system, which was deemed unsuitable given the land conditions and forage availability for livestock. Soil fertility status was classified as low, with forage production yields of 1,164.29 kg ha-1 in Pedok 3 and 984.04 kg ha-1 in Pedok 2. The land’s carrying capacity ranged from 23 to 27.02 AU year-1, based on an average livestock unit weight of 250 kg, equivalent to 23-27 adult Bali cattle.

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1. Introduction

East Kalimantan is a province in Indonesia having a population of 4.05 million people with an annual growth rate of 1.93% during the 2020-2024 period (East Kalimantan Province Statistics, 2024). This rapid population growth needs an adequate food supply, particularly animal protein from livestock products (Kurnia and Hasanudin, 2021). The demand for livestock products, specifically meat, in East Kalimantan is projected to reach 7,636.99 tons in 2024 (Indonesia Statistics, 2024) and increase further to 7,866.10 tons by 2025 (East Kalimantan Province Livestock and Animal Health Service, 2024). To address this growing need, strategies to ensure sufficient meat supply are essential. One key approach is optimizing beef cattle business management through improved feed management (Huda *et al*., 2023), as feed availability directly influences production levels (Mayulu *et al*., 2022). Feed plays a critical role in meeting the nutritional needs of cattle and supporting productivity, with feed costs comprising 65-75% of total beef cattle production expenses (Mayulu *et al*., 2024). A lack of sufficient forage and concentrate availability can lead to a decline in cattle populations, negatively impacting meat production (Alnafissa *et al*., 2024). Additionally, the absence or limited allocation of dedicated livestock land poses a significant challenge in ensuring adequate feed supply (Mayulu and Daru, 2019).

Reclaimed post-mining land presents significant potential for cattle development (Daru *et al*., 2020). This potential is further supported by coal mining companies in East Kalimantan Province that implement cattle integration programs on reclaimed land, such as PT Kaltim Prima Coal (PT. KPC). The cattle integration program at PT Kaltim Prima Coal, covering approximately 67.97 hectares, focuses on breeding Bali cattle (*Bos sondaicus*) using an extensive system (Kaltim Prima Coal, 2022). Cattle integration not only supports feed availability but also contributes to improving the ecology of post-mining land. This is achieved by accelerating soil revegetation, stimulating vegetation growth, and providing nutrient sources (Agus *et al*., 2016; Hartati and Sudarmadji, 2022). However, feed carrying capacity and grazing pressure are critical factors influencing cattle development on post-mining land (Daru *et al*., 2016). Therefore, proper feed management is essential to meet the nutritional requirements of cattle throughout the maintenance period.

2. Method

The research was conducted on the post-mining reclamation land of Pit Jupiter, PT Kaltim Prima Coal, in East Kalimantan Province from July to October 2024. An exploratory method was employed to collect soil and vegetation samples from the reclaimed land. Primary data were gathered through field observations and in-depth interviews, while vegetation sampling was carried out 80 times across a 67.82 ha pasture area. Soil samples were collected randomly from 10 points to analyze their chemical properties, including pH, organic carbon (C-Organic), total nitrogen (Total N), C/N ratio, P_2O_5, K_2O, calcium (Ca), magnesium (Mg), potassium (K), sodium (Na), cation exchange capacity (CEC), and base saturation (KB). These samples were subsequently analyzed at the Soil Science Laboratory, Faculty of Agriculture, Mulawarman University.

2.1. Observed Variables

The research observed several variables, including soil fertility based on chemical properties (such as pH, organic carbon (C-Organic), total nitrogen (Total N), C/N ratio, P_2O_5, K_2O, calcium (Ca), magnesium (Mg), potassium (K), sodium (Na), cation exchange capacity (CEC), and base saturation, forage identification, importance value index (INP), forage production, and carrying capacity.

1. Soil Fertility

Soil fertility parameters were determined through the analysis of chemical properties, including pH, C-Organic, Total N, C/N Ratio, P_2O_5, K_2O, Ca, Mg, K, Na, CEC, and base saturation. The soil fertility status was evaluated following the technical guidelines for soil fertility assessment issued by the Bogor Soil Research Center.

2. Forage Identification

Forage identification was conducted using both the vegetative and generative characteristics of plants, supported by the *PlanNet Identification* application and relevant scientific literature.

3. Importance Value Index

The importance index was calculated based on the density and frequency of each plant species using the following formula.

$$K = \frac{Number\ of\ individual\ of\ each\ type}{Sampling\ area\ (ha)}$$

Remark:

K = Density

$$KR\ (\%) = \frac{Density\ of\ each\ type}{Total\ density\ of\ all\ types}\ x\ 100\%$$

Remark:

KR = Relative density

$$F = \frac{Number\ of\ observation\ plots\ where\ a\ species\ is\ found}{Total\ observation\ plots}$$

Remark:

F = Frequency

$$F\ (\%) = \frac{Frequency\ of\ each\ type}{Total\ frequecy\ of\ all\ types}\ x\ 100\%$$

Remark:

FR = Relative frequency

$$INP\ (\%) = KR + FR$$

4. Production of Forages

Forage production was calculated based on the quantity value resulting from weighing samples in the observation plot. The following is the formula for calculating forage production (Widiyana *et al.*, 2023).

$$P\ =\ Sample\ weight\ (gm^{-2})x\ PUF\ (\%)$$

Remark:

P = Forage production

PUF = *Proper use factor*

5. Carrying Capacity

Carrying capacity was calculated based on the land area required by livestock per year. Land area requirements can be calculated using the Viosin equation. Here's the Voisin equation:

$$(Y\ -\ 1)s\ =\ r$$

Remark:

Y = Number of areas which needed by one cattle

s = Grazing period

r = Rest period or plants regrowing

Carrying capacity was calculated through this following equation.

$$Carrying\ capacity = \frac{1}{Needed\ area\ per\ year} \quad \text{...(7)}$$

Data Analysis

Primary data collected from field study were tabulated using Microsot Excel 2010 and analyzed through qualitative descriptive methods.

3. Result and Discussion

3.1. General Information of Research Location

The post-mining reclamation area of Pit Jupiter, operated by PT KPC, is located in East Kutai Regency, East Kalimantan Province, within the geographic coordinates of 117°27'7.40"–117°40'43.40" East Longitude and 0°31'20.52"–0°52'4.60" North Latitude. Agribusiness activities under the Jupiter Farm Project program are carried out on this reclaimed land based on a Memorandum of Understanding (MoU) between the East Kalimantan Provincial Government and the Sangata Baru Foundation (YSB). The program focuses on developing nurseries using an extensive system across 100 hectares of land (Kaltim Prima Coal, 2022). Additionally, 67.28 ha are allocated for grazing, divided into four *Pedok* (site): 2, 3A, 3B, and 3C (Figure 1).

Figure 1. Cattle Grazing Site in post-mining land of Pit Jupiter, PT KPC

3.2. Feed Management Procedures

Feed management in beef cattle production is influenced by the availability of local feed resources, the type of livestock, and production goals (Mayulu *et al*., 2021). At the post-mining land of Pit Jupiter operated by PT. KPC, cattle feeding is carried out using a combination of grazing and a cut-and-carry system. The feed consists entirely of forage, sourced from grazing areas and legumes naturally growing on the reclaimed land. Grazing is managed through a rotational system, with cattle spending 1–2 weeks in each site, depending on the size of the pasture within the site.

3.3. Soil Fertility Status

Soil is a vital natural resource for plant production (Khalil *et al*., 2024), including forage for livestock, as it serves as an important ingredient providing nutrients necessary for plant growth (Sheikh *et al*., 2024). Soil fertility indicates the soil's capacity to support plant growth by supplying essential nutrients and maintaining optimal chemical, physical, and biological conditions for plant development (Chikopela *et al*., 2024). The fertility status of soil can be assessed through its chemical properties, which, for the post-mining land of Pit Jupiter operated by PT KPC, are detailed in Table 1.

Table 1. Chemical Properties Analysis of Soil in Post-Mining Land of Pit Jupiter PT KPC

No	Parameter	Unit	Value	Criteria*)
1.	pH		4,42	Very acid
2.	Ca	Meq/100g	1,43	Very low
3.	Mg	Meq/100g	5,90	High
4.	K	Meq/100g	0,23	Low
5.	Na	Meq/100g	0,10	Low
6.	KTK	Meq/100g	18,60	Medium
7.	P_2O_5	ppm	2,08	Very low

No	Parameter	Unit	Value	Criteria*)
8.	K_2O	ppm	32,82	High
9.	N Total	%	0,29	Medium
10.	C-Organic	%	0,63	Very low
11.	C/N Ratio	%	2,17	Very low
12.	Base saturation	%	41,18	Medium

Source: *PTT Bogor 1995

The results of the analysis of soil chemical properties showed that the status of soil fertility in the post-mining land of Pit Jupiter PT. KPC was relatively low. The degree of acidity (pH) plays an important role in the process of plant growth and development, it influences several important soil biological and physicochemical processes, including the mineralization of soil organic matter (Xia *et al*., 2024). The degree of soil acidity in post-mining land of Pit Jupiter PT KPC was classified as very acidic (pH=4.42), the low pH is due to the oxidation of pyrite minerals (Fe_2S) to H_2SO_4 which has the potential to reduce soil pH (Erfandi, 2020). Soil with a very acidic pH affects the absorption of nutrients (Daru *et al*., 2020). Soil chemical properties such as total N, P_2O_5, K_2O, Ca, Mg, K, and Na in post-mining land of Pit Jupiter PT KPC had very low criteria (such as, Ca=1.43 Meq/100g and P_2O_5=2.08 ppm), low (such as, K=0.23 Meq/100g and Na=0.10 Meq/100g), medium (such as N total=0.29%) to high (such as Mg=5.90 Meq/100g). Total nitrogen, P_2O_5, K_2O, Ca, Mg, K, and Na are important sources of materials for growth and building plant tissue structures and are actively involved in metabolic activities in plants (Klimiene *et al*., 2021).

The C-Organic content in the soil of the post-mining land at Pit Jupiter PT. KPC was measured at 0.63%, which is classified as very low, as it falls below the 2% threshold for adequate soil organic carbon (Senevirathne and Ahamed, 2024). This low value reflects a limited amount of organic matter in the soil, primarily due to the mixing of topsoil and subsoil during mining activities (Daru, 2020). Soil organic carbon plays a vital role in improving soil structure, enhancing cation exchange capacity, providing exchange sites for essential nutrients like Ca, Mg, and K, and offering binding sites for various organochemical compounds. These functions increase soil retention, facilitate nutrient cycling, and support biological activity (Segura et al., 2024; Senevirathne and Ahamed, 2024). A low C-Organic value indicates a reduced capacity of the soil to supply the nutrients necessary for the growth of forage crops (Amare et al., 2024).

The C/N ratio is a key indicator of nitrogen mineralization potential (Chen *et al*., 2024) and serves as an effective measure for evaluating the quality of organic matter (Su *et al*., 2023). It significantly influences nitrogen release from organic matter (Li *et al*., 2022) and plays a critical role in soil biology and the composition of microbial communities (Reyna *et al*., 2023). Soil microorganisms rely on carbon and nitrogen for their metabolic activities. When the C/N ratio is high, microbial activity decreases, whereas a low C/N ratio results in excess nitrogen that cannot be assimilated by microorganisms, leading to nitrogen loss through ammonia volatilization or denitrification (Purnomo *et al*., 2017). In the post-mining land of PT KPC, the C/N ratio was very low at 2.17%. This low value accelerates the rate of nitrogen mineralization, which can result in higher emissions of N_2O and the release of NH_3. Such rapid nitrogen loss indicates a greater likelihood of nitrogen depletion from the soil (Jia *et al*., 2022).

Cation exchange capacity (CEC) measures a soil's ability to absorb and exchange cations, serving as a critical indicator for mineralogical characterization and soil fertility (Mustafa *et al*., 2024; Peng *et al*., 2024). It plays a vital role in nutrient availability and plant growth (Antonangelo *et al*., 2024). The nutrient retention capacity of the soil, reflected in a CEC value of 18.60 Meq/100g, falls within the medium category. This value is influenced by factors such as the decomposition of organic matter, which produces negatively charged organic acids (anions) that bind positively charged ions (cations) in soil colloids, as well as by soil type, texture, pH, and mineral composition (Kaya *et al*., 2024). A low CEC indicates limited nutrient content in the soil (Gonzalez *et al*., 2024) and restricts the availability of mineral nutrients for plants (Yang et al., 2024). CEC values tend to increase with rising soil pH (Peng *et al*., 2024), and higher CEC values suggest greater soil capacity for nutrient retention and exchange, enhancing overall soil fertility (Amare *et al*., 2024). Both total nitrogen and

CEC are essential for nutrient availability and retention, directly impacting crop yield and quality by supporting root growth, water availability, and the soil's ability to provide key nutrients (Amare *et al*., 2024).

Base saturation is a reliable indicator of soil fertility (Oliveira *et al.*, 2023) and reflects the availability of essential elements in the soil (Kabala and Labaz, 2018). It represents the proportion of four base cations (Ca^{2+}, Mg^{2+}, K^{+}, and Na^{+}) relative to the soil's cation exchange capacity (CEC) (Zhang *et al.*, 2023). According to the research findings, the base saturation level in the post-mining land of Pit Jupiter PT. KPC was categorized as medium at 41.18%. A higher base saturation percentage indicates improved nutrient availability, whereas a lower percentage suggests soil acidification (Zhang *et al*., 2023).

3.4. Pasture Potential

The forage species found on post-mining land are highly diverse, consisting mainly of native plants and species intentionally cultivated for specific purposes (Daru, 2020). This diversity is crucial for the growth and health of cattle, as the nutrients in different forages can complement each other, achieving an ideal balance for livestock nutrition (Daru *et al*., 2023). Vegetation with forage potential belongs to four primary families: *Fabaceae*, *Cyperaceae*, *Onagraceae*, and *Poaceae*. According to vegetation identification conducted using the Halls method, 32 species from 13 families were identified across Site 3 and Site 2 (Table 2).

Table 2. Plants Identification Result in Post-Mining Land of Pit Jupiter PT. KPC

No	Local Name	Species	Family	Status
1	-	*Rhynchospora contracta (Nees)* J.Raynal	Cyperaceae	Weed
2	Akasia Mangium	*Acacia mangium* Willd.	Fabaceae	Legum
3	Alang - alang	*Imperata cylindrica* (L.) Beauv	Poaceae	Grass
4	Babadotan	*Agerantum conyzoides* L.	Asteraceae	Weed
5	Babawangan	*Fimbristylis miliacea*	Cyperaceae	Weed
6	Buyung-buyung	*Vernonia cinerea* (L.) Les	Asteraceae	Weed
7	Cacabean	*Ludwigia octovalvis*	Onagraceae	Weed
8	Crotalaria	*Crotalaria*	Fabaceae	Legum
9	Jarem	*Grona triflora*	Fabaceae	Legum
10	Johar	*Cassia siamea*	Fabaceae	Legum
11	Jukutan	*Cyperus brevifolius*	Cyperaceae	Weed
12	Kancing Baju	*Glochidion littorale*	Phyllanthaceae	Weed
13	Karamunting	*Melastoma malabathricum*	Melastomaceae	Weed
14	Kirinyuh	*Choromolaena odorata*	Asteraceae	Weed
15	Kumpai Segitiga	*Cyperus polystachyos*	Cyperaceae	Weed
16	*Lesser Fimbristylis*	*Fimbristylis littolaris* Gaudich.	Cyperaceae	Weed
17	Pakis Resam	*Dicranopteris linearis* (Burm. f.) Underw	Gleicheniaceae	Weed
18	Paku Hata	*Lygodium circinnatum*	Lygodiaceae	Weed
19	Paku Kawat	*Lycopodium cernuum* L.	Lycopodiaceae	Weed
20	Paku ribu-ribu garege halus	*Lygodium microphyllum* (cav) R.Br	Lygodiaceae	Weed
21	Patikan Kebo	*Euphorbia hirta* L.	Euphorbiaceae	Weed
22	Purun Bajang	*Eleocharis ochrostachys* Steud.	Cyperaceae	Weed
23	Putri Malu	*Mimosa pudica*	Fabaceae	Legum
24	Rumput Australia	*Paspalum dilatatum*	Poaceae	Grass
25	Rumput Beha	*Brachiaria humidicola*	Poaceae	Grass
26	Rumput Paitan	*Paspalum conjugatum*	Poaceae	Grass
27	Rumput Signal	*Brachiaria decumbens*	Poaceae	Grass

No	Local Name	Species	Family	Status
28	Rumput Tapak Burung	*Murdannia nudiflora* (L.) Brenan	Commelinaceae	Weed
29	Rumput Teki	*Cyperus esculentus*	Cyperaceae	Weed
30	Sentro	*Centrocema pubscens*	Fabaceae	Legum
31	Sesenap	*Alysicarpus vaginalis* (L.) DC.	Fabaceae	Legum
32	*Spider Brake*	*Pteris multifida*	Pteridaceae	Weed

Source: Primary Data 2024.

The results of the INP analysis in the post-mining land showed that the vegetation with the highest INP value from Site 3 and Site 2 were Paitan grass (*Paspalum conjugatum*) with an INP value of 59.53% and 95.12% respectively.

Table 3. Important Value Index in Site 2

Local Name	Species	Number of Individu	KR (%)	FR (%)	INP (%)
Paitan Grass	*Paspalum Conjugatum*	2.687	74,64	20,48	95,12
Jukutan	*Cyperus brevifolius*	446	12,39	8,43	20,82
Jarem	*Grona triflora*	102	2,83	10,84	13,68
Babawangan	*Fimbristylis miliacea*	88	2,44	8,43	10,88
Rumput Australia	*Paspalum dilatatum*	85	2,36	4,82	7,18
Sesenap	*Alysicarpus vaginalis* (L.) DC.	52	1,44	2,41	3,85
Rumput Tapak Burung	Murdannia nudiflora (L.) Brenan	40	1,11	1,20	2,32
Kirinyuh	*Choromoalena odorata*	36	1,00	6,02	7,02
Putri Malu	*Mimosa pudica*	11	0,31	6,02	6,33
Lesser fimbristylis	*Fimbristylis littolaris Gaudich.*	8	0,22	2,41	2,63
Akasia Mangium	*Acacia mangium* Willd.	8	0,22	3,61	3,84
Karamunting	*Melastoma malabathricum*	7	0,19	7,23	7,42
Kancing Baju	*Glochidion littorale*	7	0,19	2,41	2,60
Paku ribu-ribu garege halus	*Lygodium microphyllum* (cav) R.Br	5	0,14	4,82	4,96
Babadotan	*Ageratum conyzoides*	5	0,14	2,41	2,55
Rumput Beha	*Brachiaria humidicola* cv. Tully	5	0,14	1,20	1,34
Johar	*Cassia siamea*	4	0,11	1,20	1,32
Buyung-buyung	*Vernonia cinerea* (L.) Les	2	0,06	2,41	2,47
Rumput Teki	*Cyperus esculentus*	1	0,03	1,20	1,23
Crotalaria	*Crotalaria*	1	0,03	2,41	2,44
Total		3.600			

Source: Primary Data 2024

Table 4. Important Value Index in Site 3

Local Name	*Spesies*	Number of Individu	KR (%)	FR (%)	INP (%)
Paitan Grass	*Paspalum conjugatum*	3.547	43,64	15,89	59,53
Beha Grass	*Brachiaria humidicola* cv. Tully	1.254	15,43	8,72	24,15
Purun Bajang	*Eleocharis ochrostachys Steud*	948	11,66	1,25	12,91
Babawangan	*Fimbristylis miliacea*	338	4,16	9,97	14,13
Putri Malu	*Mimosa pudica*	313	3,85	9,35	13,20
Jukutan	*Cyperus brevifolius*	297	3,65	2,49	6,15
Jarem	*Grona triflora*	261	3,21	9,35	12,56

Local Name	*Spesies*	Number of Individu	KR (%)	FR (%)	INP (%)
Karamunting	*Melastoma malabathricum*	246	3,03	10,59	13,62
Paku ribu-ribu garege halus	*Lygodium microphyllum* (cav) R.Br	138	1,70	7,17	8,86
Pakis Resam	*Dicranopteris linearis* (Burm. f.) Underw	135	1,66	3,12	4,78
Babadotan	*Agerantum conyzoides* L	133	1,64	3,74	5,37
Kumpai Segitiga	*Cyperus polystachyos*	107	1,32	1,25	2,56
Lesser fimbristylis	*Fimbristylis littolaris Gaudich.*	97	1,19	1,87	3,06
Rumput Signal	*Brachiaria decumbens*	86	1,06	0,93	1,99
Paku Kawat	*Lycopodium cernuum* L.	66	0,81	3,12	3,93
Kirinyuh	*Choromolaena odorata*	53	0,65	4,98	5,64
-	*Rhynchospora contracta* (Nees) J.Raynal	50	0,62	0,93	1,55
Rumput Teki	*Cyperus esculentus*	31	0,38	0,62	1,00
Cacabean	*Ludwigia octovalvis*	12	0,15	0,31	0,46
Kancing Baju	*Glochidion littorale*	3	0,04	0,93	0,97
Paku Hata	*Lygodium circinnatum*	3	0,04	0,62	0,66
Akasia Mangium	*Acacia Mangium* Willd.	2	0,02	0,62	0,65
Crotalaria	*Crotalaria*	2	0,02	0,62	0,65
Johar	*Cassia siamea*	2	0,02	0,62	0,65
Patikan Kebo	*Euphorbia hirta* L.	1	0,01	0,31	0,32
Sentro	*Centrocema pubscens*	1	0,01	0,31	0,32
Spider Brake	*Pteris multifida*	1	0,01	0,31	0,32
Total		8.127			

Source: Primary Data 2024

The high Importance Value Index (INP) of *Paspalum conjugatum* demonstrates its adaptability and competitiveness against other forage species on post-mining land. *Paspalum conjugatum* is a perennial grass with significant potential as a forage source and is commonly found in post-coal mining areas (Daru *et al*., 2020). Research by Daru *et al*. (2020) reported an INP value of 44.49% for *Paspalum conjugatum* on post-mining land at PT. Multi Harapan Utama (PT. MHU) and a range of 55.01–166.67 ind/ha on reclamation land at PT. Bukit Asam Tbk (Yuningsih *et al*., 2021). Its dominance is attributed to its prolific seed production, with up to 1,500 seeds, and its extensive stolon spread, allowing it to thrive on low-fertility soils (Daru *et al*., 2020; Hariandi *et al*., 2019). Another dominant grass species on the post-mining land of Pit Jupiter PT. KPC is *Brachiaria humidicola* cv. Tully (Beha grass), which achieved an INP of 24.15% in Site 3 (Table 4). Its dominance is likely due to its robust vegetative growth through stolons and rhizomes, forming dense grass coverage (Daru, 2020). Additionally, *Cyperus brevifolius* (*Jukutan*) is the most dominant weed, with an INP value of 20.82% (Table 3). This species exhibits high seed viability and persistence on disturbed lands and can perform phytoremediation on hydrocarbon-contaminated soils through internal defense mechanisms, soil improvement, and hydrocarbon metabolism (Chakravarty and Deka, 2021; Fan *et al*., 2024; Zairina and Mondiana, 2020). These three species, characterized by their high INP values, share common traits: they belong to the order *Poales* and utilize the C4 photosynthesis pathway, which enhances their efficiency in spreading and adapting to various conditions (Fan *et al*., 2024; Horrocks et al., 2019).

Pastureland with diverse C4 plant species has the potential to enhance productivity and utilize resources more efficiently than monoculture pastures (Silva *et al*., 2015). In the post-mining land of Pit Jupiter PT. KPC, forage production was 1,164.29 kg ha^{-1} at Site 3 and 984.04 $kgha^{-1}$ at Site 2. These differences in yield were attributed to variations in soil fertility and plant species on the reclaimed land. Forage production on post-mining land directly influences carrying capacity, which measures the ability of pastures to provide sufficient forage for livestock within a specific area (Sari and Muhtarudin, 2016). The carrying capacity values ranged from 0.40 to 0.47 ST ha^{-1}/$year^{-1}$, indicating that forage availability on the post-mining land of Pit Jupiter PT. KPC was relatively low and insufficient to meet the feed requirements of cattle.

Evaluation of Feed Management

Feed management on post-mining land employs an extensive system, but this approach is poorly suited to the land's conditions and the limited forage availability needed to support livestock. This mismatch is due to low soil fertility, limited carrying capacity, and the presence of invasive weeds. Low soil fertility means the land cannot supply essential nutrients for plant growth (Daru, 2020), while the presence of weeds—plants with low palatability that compete with grasses and legumes—further reduces pasture productivity (Sema *et al*., 2021). To improve soil fertility on post-mining land, measures such as fertilization, liming, legume planting, inoculation, and weed control can be implemented (Daru *et al*., 2020; Marta, 2019; Maulana *et al*., 2020). Based on its carrying capacity, post-mining land used as pastureland can sustain only 23–27.02 livestock units (250 kg per unit) annually, equivalent to 23–27 adult livestock. However, this is insufficient compared to the 57.5 livestock units maintained in the breeding program. The low carrying capacity is likely due to the short grazing rotation, with 30 days of grazing followed by a 70-day forage regrowth period (Daru *et al*., 2020).

Analysis of soil chemical properties (Table 1) reveals that the nutrient content falls within low criteria, potentially leading to mineral deficiencies in plants. Ruminants raised on such mineral-deficient land require supplemental feed to address potential deficiencies. Accurate mineral formulation is essential to ensure that livestock meet their mineral requirements, compensating for what is lacking in forage through additional feed supplementation (Hanafiah *et al*., 2024). Pasturelands typically produce feed with variable energy and protein levels, which may not fully meet the nutritional needs of livestock under extensive systems. To optimize livestock productivity, concentrates should be supplemented based on pasture quality and the specific nutritional needs of the animals.

4. Conclusion

The reclaimed mining-land from Pit Jupiter PT KPC can be effectively utilized to support extensive cattle rearing system. However, low soil quality and limited forage productivity pose significant challenges in meeting the feed requirements of Bali cattle. To address these issues, strategies such as enhancing soil fertility, introducing high-yield grass varieties, and adopting rotational grazing practices are essential to boost forage productivity.

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