

## Characterization of Potential Analysis and Biodiversity of Grassland

Darmawati Darmawati<sup>a</sup>, Rinduwati Rinduwati<sup>\*</sup>, Ambo Ako<sup>b</sup>

<sup>a</sup>Department of Nutrition and Animal Feed, Faculty of Animal Science, University of Hasanuddin, Jl. Perintis Kemerdekaan KM. 10, Makassar

<sup>b</sup>Department of Animal Production, Faculty of Animal Science, University of Hasanuddin, Jl. Perintis Kemerdekaan KM. 10, Makassar

\*Corresponding author: E-mail: [rinduwatit@yahoo.com](mailto:rinduwatit@yahoo.com)

### ARTICLE INFO

Article history:  
Submission:  
Agustus 10, 2023  
Accepted:  
December 23,  
2023  
Published:  
January 6, 2023

### ABSTRACT

This study aimed to determine forage availability on pastures by analyzing pastures' forage quality and evaluating pastures' biodiversity in Tanete Riaja District, Barru Regency. The results of this study indicated that the botanical composition (BC) in the Tanete Riaja District was shallow because weeds still dominate the pasture in this area by 60%. The biodiversity richness index (BRI) in the pasture of Tanete Riaja District was found in grass species with a margalef index (MI) of 3.09 and in legume species with an MI of 1.21. In contrast, the grass species' diversity index value (DI) was 0.29 Shannon-Weiner index (SWI), and the legume species was 0.36 SWI. The value DI on grass and legume species was classified in the low category. At the research location, there was 0.22 tons/ha of total forage production, while forage livestock could eat 0.15 tons/ha. The results obtained in this study indicated that the carrying capacity or pasture capacity of the natural pasture (NF) area was 0.06 UT/Ha, which was classified as heavy pasture. The results of this study indicated that the percentage of pasture forage in Tanete Riaja, Barru Regency, was dominated by weeds at 37.61%, grass at 48.35%, and legumes at 14.04%. The CC of the pasture area was 0.4 ST / Ha / Year, which is classified as heavy pasture.

Keywords: Carrying Capacity, Rumination, Forage, Biodiversity, Grass

### INTRODUCTION

Forage is a determining factor for success in livestock development. To meet the needs of livestock, forage that has high quality is needed, such as sufficient quantity (SQ) and sustainable availability (SA). Provision on pastures can be in the form of grass and legumes with a composition of 60% grass and 40% legume. However, pasture development areas experience land conversion and land degradation. To streamline livestock performance and production, the government and livestock sector are targeting land potential for developing pastures, which are also centers for developing beef cattle.

One indicator of good grassland (GG) is vegetation productivity (VP). It is one of the most important parameters for calculating the CC of livestock [1]. Several pasture productivity (PP)

studies have been carried out in small sample areas using traditional methods. One way to assess pasture quality on a large scale is through remote sensing techniques (spatial approach) [1]. This remote sensing technology (RST) has two forms of data structures, which are raster data structures (RDT) and vector data structures (VDT). Both data structures have advantages and disadvantages. The RDT can shorten the stacking time, but the information displayed in the attributes needs to be more complete than the VDT. RDT also requires more storage space (hard disk) than VDT. However, the RDT provides another advantage: integration with remote sensing data (RSD).

Currently, the existence of RST makes it easier to monitor the dynamics of pasture yields in different areas [1]. In addition, several researchers have reviewed the climatic productivity of pastures and their ability to calculate theoretical livestock CC Pasture, which is an ecological basis for the source of forage for the development of ruminants in the tropics with the changing seasons. The quality of the pasture can be determined through identification of forage, measurement of forage production and quality, calculation of CC, and biodiversity (BD).

In Indonesia, particularly in South Sulawesi, Barru Regency is one of the regencies with the most potential for developing beef cattle because of available pasture land covering an area of 1,174.72 km<sup>2</sup> [2]. Still, its potential cannot be optimized further. Therefore, it is necessary to conduct more comprehensive research to know the steps to optimize natural pastures to increase the productivity of forage for ruminants and, simultaneously, a preventive effort to prevent land degradation of pasture lands. Analyzing forage quality feed on grazing pastures and evaluating the existing biodiversity (BD) in Tanete Riaja District, Barru Regency pastures.

## **MATERIALS AND METHODS**

### **Time and Research Site**

This research was conducted from September to December 2022 in Tanete Riaja District, Barru Regency. The location selection was carried out purposively (purposive sampling) based on the consideration that the location is a development area for the purification of Bali cattle with a land area of 174.29 Km<sup>2</sup> with a total cattle population of 11,126 heads in Tanete Riaja District, 45,242 heads in all of Barru Regency. This requires a source of forage from pastures and other sources. In addition, the topographical area of Barru Regency is mainly dominated by natural pasture areas whose quality, forage productivity, and biodiversity are unknown.

The study sites have very different botanical compositions (BC). Lompo Tengah Village (LTV) has more weeds than grass. Kading Village (KV) has a higher percentage of grass than weeds. This is because LTV has more cattle to graze and there is no land rest period (Over Grazing). A map of the research area can be seen in Figure 1.

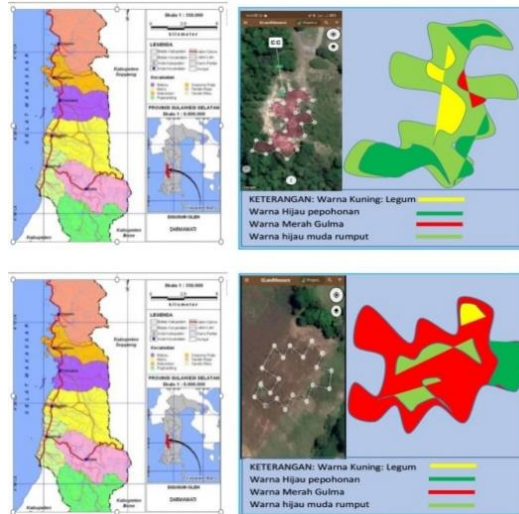


Figure 1. Map of the research area of the Tanete Riaja District, Barru Regency.  
Source: Primary data using Google Earth: processed by the author in 2023.

### Analysis and Sampling

This research was classified as descriptive, using qualitative and quantitative approaches through observational surveys and documentation studies. This descriptive study aimed to provide a systematic, careful, and accurate description of the condition of the pasture areas in the study area. Land descriptive analysis (LDA) can be done using a spatial system using Geographic information system software technology [3].

Source Power forage feed and descriptive land were identified using a spatial approach using Geographic information system technology, including vector and raster data processing using vector and raster data processing software. Identification of pasture lands using the supervised classification method, which includes radiometric correction, geometric correction, training area, classification, and validation of training data with objects [4].

### Analysis of Botanical Composition

Botanical composition analysis was carried out using the “Dry weight rank” *method* [5]. This method was used to determine the BC of grazing pasture-based (GFB) material dry by cutting/separating the type of the remaining grass. The BC can be quantified using 1 m × 1 m quadrants made of metal or pipes placed randomly in the pasture. All species in the quadrant are recorded, and the percentages ranking first, second, and third are estimated.

### Biodiversity (BD)

Biodiversity (BD) calculations were based on richness, diversity, and evenness. Sampling was carried out using a quadrant frame measuring 1 m × 1 m, which was placed by randomly throwing the quadrants in areas shaded by trees and areas without shade 20 times in each area. The forage in the quadrants was cut as high as 5 cm from the soil surface. All species were recorded

and stored in sample bags after being separated according to type. The parameters measured at this stage of the study were Richness using the Margalef index (MI), Diversity using the Shannon-Wiener Index (SWI) [6], and Evenness using the Pielou Index (PI).

Margalef Index [7];

$$D_{mg} = \frac{S-1}{\ln N}$$

Description:

Dmg = Richness

S = Number of species

N = Total number of individuals of all observed species

Shannon-Wiener Index [8];

$$H' = \sum (pi) (\ln)$$

Description:

H = Shannon-Wiener diversity index

S = Number of Species

$pi = \frac{1}{N} \ln N$

in = Number of individual species I

N = Total number of individuals

pi = Number of individuals of a species

Pielou Index:

$$E = \frac{H}{\ln S}$$

Description:

H = Shannon-Wiener diversity index

S = number of species under observation

### **Forage Production**

Forage production is obtained by cutting the forage in quadrants as high as 5 cm from the soil surface and then weighing it to obtain its fresh weight. The value obtained is converted into hectares. According to Demanet et al. [9], the formula for calculating forage production correlates dry matter production with plant height. The formula is as follows:

$$Y = 0.51 + 0.098 X$$

Description:

Y = Production of dry matter (Kg/m<sup>2</sup>)

X = plant height

## Carrying Capacity (CC) Analysis

Measurement of pasture carrying capacity First, a quadrant measuring 1 m × 1 m was randomly placed (thrown) on the research field, then all the forage in the quadrant was cut to a height of 0.5 cm from the ground surface. Furthermore, the cutting results were put into a plastic bag and then weighed for each species that had been separated. The second sampling was carried out to the right and left by 5 steps-10 steps. Samples one and two are called clusters. Capacity analysis can be calculated using the Addler method as follows:

Total Production	=	Calculated according to the number of harvests and harvest season
PUF production	=	Total production x PUF (forage palatability production)
Rate water	=	PUF production x average content of forage samples. Production
Dry Matter	=	PUF production-water content
Carrying Capacity	=	Dry matter production/ average dry matter consumption requirement of cattle based on body weigh

## RESULTS AND DISCUSSIONS

### Botanical Composition

A botanical composition (BC) is a number used to determine the quality of pasture that can affect livestock activity [8]. Most pastures in Tanete Riaja District, Barru Regency, are weeds. This is because weeds grow faster in open land and quickly in the sun, have a robust root system resistant to trampling and cattle grabbing, and increase after cutting, inhibiting legume growth [9].

The BC of a pasture is not constant. This is influenced by climate, soil conditions, and grazing system [10]. A pasture's high or low quality is closely related to the BC contained in the pasture[10].

Table 1. Percentage of grasses, legumes, and weeds in Tanete Riaja District, Barru Regency.

Forage type	%
<b>Grass</b>	
Grinting grass ( <i>Cynodon dactylon</i> )	7.12
Nut grass ( <i>Cyperus rotundus</i> )	5.85
<i>Epidendrum</i> spp	3.59
<i>Mecardonia procumbens</i>	3.44
Jungle rice ( <i>Echinocola colona</i> L.)	2.82
Hilograss ( <i>Paspalum conjugatum</i> L.)	4.69
<i>Stellaria neglecta</i>	1.19
Goose grass ( <i>Eleusina indica</i> )	0.83
Broad-leave carpetgrass ( <i>Axonopus compresus</i> )	0.53
Hairy crabgrass ( <i>Digitaria sanguinalis</i> L)	0.89
Bengal grass ( <i>Panicum maximum</i> )	0.30
African grass ( <i>African grass</i> )	0.30
Licorice weed ( <i>Scoparia dulcis</i> L)	3.21

Elephant grass ( <i>Pennisetum purpureum</i> )	0.15
Egyptian grass ( <i>Dactyloctenium aegyptium</i> L)	0.40
Nut grass ( <i>Cyperus rotundus</i> )	5.85
Love grass ( <i>Crysopegon aciculatus</i> )	1.25
Lakeshore bulrush ( <i>Schoenoplectus lacustris</i> )	1.28
Woodland False Buttonweed ( <i>Spermacoce remota</i> )	1.37
<i>Dichanthelium clandestine</i>	1.69
<i>Imperata cylindrica</i>	4.57
Tuberous Sword Fern ( <i>Neprolepis cordifolia</i> )	1.99
Dodder ( <i>Cuscuta</i> sp.)	0.80
<b>Legumes</b>	
Little ironweed ( <i>Cyanthillium cinereum</i> )	2.40
Green amaranth ( <i>Amaranthus viridis</i> )	1.01
Marsh seedbox ( <i>Ludwigia palustris</i> )	1.40
Chamber bitter ( <i>Pyhllantus urinaria</i> )	0.24
Calopo ( <i>Calopogonium mucunoides</i> )	2.05
Desmodium ( <i>Desmodium triflorum</i> )	5.49
Alyce clover( <i>Alysicarpus vaginalis</i> L)	1.28
<b>Weed</b>	
False daisy ( <i>Eclipta prostrata</i> L)	6.41
Creeping inchplant ( <i>Callisia repens</i> L)	1.19
Siam weed ( <i>Chromolaena odorata</i> L)	4.07
<i>Gallinsuga quadriradiata</i>	1.78
Common speedwell ( <i>Veronica arvensis</i> L)	1.04
Sweet potato ( <i>Ipomoena batatas</i> )	1.78
Horse mint ( <i>Mentha logifolia</i> )	0.98
Billygoat-weed ( <i>Ageratum conyzoides</i> L)	0.92
Malabar melastome ( <i>Malasthoma malabatricum</i> )	1.31
Tobacco weed ( <i>Elephantopus mollis kunth</i> )	1.51
<i>Crepis pulchara</i>	0.80
Italian hawksbeard ( <i>Crepis bursifolia</i> )	0.86
Candle Bush ( <i>Senna alata</i> )	2.20
Lantana ( <i>Lantana camara</i> )	2.14
Flax-leaf fleabane ( <i>Erigeron bonariensess</i> )	0.89
Fireweed ( <i>Crassocephalum crepidiodes</i> )	1.04
Ipomoeana lecnosa L	0.92
Rubus fruticos	0.83
Ambrosia artemifolia	3.44
Starcypheta jamainces	2.26
Nepethes gracilis korth	1.25
<b>Total</b>	<b>100</b>

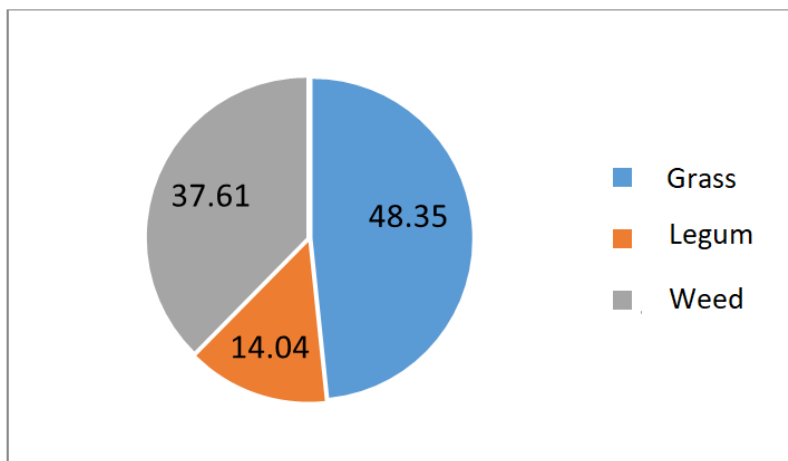


Figure 2. Percentage diagram of grass, legume, and weed species in Tanete Riaja District, Barru Regency.

Most pastures in Tanete Riaja District, Barru Regency, are weeds. This is because weeds grow faster in open land and efficiently under the sun's rays, have a robust root system resistant to trampling and cattle grabbing, and regress quickly after cutting, inhibiting legume growth [11]. The BC of a pasture is not constant. This is influenced by climate, soil conditions, and grazing systems [11]. The high or low quality of a pasture is closely related to the botanical composition contained in the pasture [12]. This is because other plants grow faster in open fields and quickly under sunlight. They have a robust root system, so they are resistant to trampling and being pulled by livestock and re-grow very soon after cutting, thus inhibiting the growth of legumes [13].

The BC in Tanete Riaja District is very low because weeds still dominate the grazing areas in this area by 60%, which are *Eclipta prostrata L*, *Callisia repens L*, *Chromolaena odorata L*, *Gallinsuga quadriradiata*, *Veronica arvensis L*, *Ipomoena batatas*, *Mentha logifolia*, *Ageratum conyzoides L*, *Malasthoma malabatricum*, *Elephantopus mollis Kunth*, *Crepis pulchra*, *Crepis bulcifolis*, *Senna alata*, *Lantana camara*, *Erigeron bonariensess*, *Crassocephalum crepidiodes*, *Ipomoeana lecanora L*, *Rubus fruticos*, *Ambrosia artemifolia*, *Staracypheta jamainces*, *Nepethes gracilis* Korth (Table 1) which percentage are high and the plants can not be eaten by cattle. The low level of Leguminosae in pastures in Tanete Riaja District is because Leguminosae has prolonged growth compared to grass species. In addition, poor management, such as the number of cattle grazing does not match the amount of forage available, and the demand for forage cannot be fulfilled because too many cattle are grazed on the land.

Good pasture areas (GFA) for grazing livestock are pastures with sufficient forage sources of around 60% grass and 40% legumes to meet the nutritional needs of the grazed ruminants [14]. A good pasture area for grazing livestock has sufficient forage sources of around 60% grass and 40% legumes to meet the nutritional needs of the grazed ruminants [15].

## Biodiversity (BD)

Biodiversity (BD) is ecosystems' various types, kinds, and forms of life. BD is a wealth on this earth with millions of plants (flora), animals (fauna), and microorganisms, as well as the genetics they contain and the ecosystems they build [16]. Biodiversity is a wealth on this earth, with millions of plants (flora), animals (fauna), and microorganisms, as well as the genetics they contain and the ecosystems they build [17].

The results of the survey and observation of forage plant biodiversity in 2023 can be seen in Table 2, which shows the species and types of forage plants in the condition of the grazing area in Tanete Riaja District, Barru Regency.

Table 2. Biodiversity value of pastures in District Tanete Riaja, Regency Barru.

Parameter	Forage Composition	
	Grass	Legumes
Total species	15	4
Richness Index (RI)	3.09	1.21
Diversity Index (RI)	0.29	0.36
Evenness Index (EI)	0.11	0.25

## Richness Index (RI)

The richness of plant species can be calculated using several methods, including the margalef index (MI). The value of MI will be more significant along with the broader sample plots used and the higher the diversity, as indicated by the more extraordinary richness of the species [18].

Based on the results of processing the data collected in this study, it can be seen in Table 2 that the value of the richness index in the Tanete Riaja District was found in grass species with an MI of 3.09 and in legume species with an MI of 1.21. The value of the richness index is influenced by the number of species that grow in an area. In Table 5, it can be seen that the RI value of grass species is greater than that of legumes. This is the opinion of Perlman and Milder [19], who state that the wealth value of an ecosystem is influenced by the number of species that grow, the area, and different habitat conditions.

## Diversity Index (DI)

The diversity index combines species richness and evenness into one value. Indices of diversity are often challenging to interpret because the same index value can be generated from various combinations of species richness and evenness. The same diversity value can be generated from a community with low species richness but high evenness or a community with high species richness but low evenness [20].



Based on the processing results of the data collected in this study, it can be seen in Table 2 that the DI value for grass species is 0.29 SWI, and for legume species is 0.36 SWI. The diversity index value ( $H'$ ) of grass and legume species is in a low category.

The value of the DI can be seen from two factors: the value of species richness and even the distribution of species in an area. The DI is often difficult to interpret because the same index value can result from different species richness and evenness combinations. The same diversity value can be generated from a community with low species richness but high evenness or a community with high species richness but low evenness. The same diversity value can result from a community with low species richness but high evenness or a community with high species richness but low evenness [21].

### Evenness Index (EI)

The evenness index value measures the degree of evenness of the abundance of individual species in a community. Evenness describes the balance between one community and another. An evenness value close to one indicates that a community is more evenly distributed, whereas if the value is close to 0, it is more unequal [22].

Based on the processing results of the data collected in this study, it can be seen in Table 2 that the EI values found for grass species are 0.11 PI, and for legume species are 0.25 PI. The EI value can show the distribution of living vegetation in an ecosystem. In this study, the evenness index value (E) is high. This is in the opinion of Hawolambani et al. [23] states that the value of  $E < 0.3$  belongs to the low category,  $0.3 < E < 0.6$  belongs to the medium category, and  $E > 0.6$  belongs to the high category.

### Forage Production

Grass is a plant that grows fast and produces more biomass quickly compared to other plants [24]. The results of forage production in grazing areas in Tanete Riaja District, Barru Regency, are presented in Table 3.

**Table 3.** Forage production in natural grazing in Tanete Riaja District, Barru Regency.

Forage type	Fresh weight (Tons/ha)	Dry weight (Tons/ha)
Grass	0.32	0.08
Legumes	0.27	0.07
Another plant	0.34	0.07
<b>Total</b>	<b>0.93</b>	<b>0.22</b>

Forage types are classified into three classes, namely grass (*Gramineae*), legumes (*Leguminosae*), and other plants (weeds). The low proportion of leguminous plants in natural pastures causes a low forage quality on pastures. Adequacy of Leguminosae in pasture land is very necessary because Leguminosae has an excellent nutritional content compared to grass. The availability of leguminous plants is essential for a pasture because leguminous plants have a higher nutrient content, especially protein, than grass plants [25].

Legumes in pasture have prolonged growth compared to other types of grasses and poor management, such as grazing pressure that does not match the amount of forage available so that the forage taken by livestock can disappear from the pasture, no regrowth occurs, and it is challenging to get forage, especially legumes in the dry season.

One of the problems that often occurs in raising ruminants is the availability of forage. Forage is integral to livestock development, especially ruminants [26]. Tropical countries with only two seasons, like Indonesia, usually experience fluctuations in forage availability. It is sufficient and abundant during the rainy season, while during the dry season, there is a scarcity of forage resulting from reduced production [27].

### **Carrying Capacity (CC)**

Carrying capacity is the ability of the pasture to produce forage, which is needed by several cattle grazed in a specific unit area, and the capacity of the pasture to accommodate livestock per hectare. Capacity is the ability to analyze an area of pasture land to accommodate several livestock [28]. The higher the forage productivity in a grazing area, the higher the livestock carrying capacity, as indicated by the number of livestock that can be grazed [24].

The results obtained in this study indicate that the carrying capacity or grazing capacity in the Tanete Riaja district, Barru Regency of 0.4 UT/Ha, is classified as heavy grazing land. The opinion of Field supports this [28], who reported that the carrying capacity of the tropics is generally 2 – 7 UT/ha/year, also supported by the opinion [29] which states that a pasture is declared productive if it has a minimum capacity of 2.5 UT/ha/year. Thus, the CC of natural pastures in Central Lompo is still very low (0.61 UT/ha/year); this is caused by other supporting factors, such as weeds and the lack of legumes that still dominate the BC. The low CC in Tanete Riaja is due to the high invasion of weeds compared to grasses and legumes; this is due to the very high number of cattle grazed, reaching 30-40 cattle, which devour forage, which results in the grass and legumes being eaten by livestock, so weeds dominate the pasture land [30]. Grazing capacity reflects the balance between available forage and the number of livestock units grazed per unit of time.

### **CONCLUSIONS**

Based on the results of the research that has been carried out, it can be concluded that the percentage of forage pastures in Tanete Riaja, Barru Regency, was dominated by weeds at 37.61%, grass at 48.35% and legumes at 14.04%. The capacity of the paddy area is 0.4 ST/Ha/Year, classified as heavy pasture land.

### **ACKNOWLEDGEMENT**

I express my deepest gratitude to my Supervisor, Dean, and Postgraduate program at Hasanuddin University. I sincerely thank my research partners, laboratory assistants for their guidance, and farmers in Tanete Riaja District, Barru Regency, for their partnership with this research project.

## REFERENCES

- [1] R. Rinduwati, "One Way to Assess the Quality of Pastures on a Large Scale is Through Remote Sensing Techniques (Spatial Approach)", *Pedosphere*, Vol. 20, no. 3, pp. 342–351, 2010, doi: 10.1016/S1002-0160(10)60023-9.
- [2] BPS, "Kondisi Geografis Kabupaten Barru," 2022.
- [3] S. Yan and W. Yu, "Formal Verification of a Topological Spatial Relations Model for Geographic Information Systems in Coq", *Mathematics*, Vol. 11, no. 5, pp. 1079, 2023.
- [4] B.R. Nasibov, Y.A. Polevshikova, A.O. Xomidov, and M.R. Nasibova, "Monitoring of Land Cover Using Satellite Images on the Example of the Fergana Valley of Uzbekistan", *AIP Conf. Proc.* 2612, 020028, 2023.
- [5] Rollinson, H.R., 2014. *Using geochemical data: evaluation, presentation, interpretation*. Routledge.
- [6] M.K. Konopiński, "Shannon Diversity Index: A Call to Replace the Original Shannon's Formula with Unbiased Estimator in the Population Genetics Studies", *PeerJ*, Vol. 8, pp. e9391, 2020.
- [7] Se'u, V.E., Karti, P.D.M.H. and Abdullah, L., 2015. Botanical composition, grass production, and carrying capacity of pasture in Timor Tengah Selatan District. *Media Peternakan*, 38(3), pp.176-182. [8] S. Gamito, "Caution is Needed When Applying Margalef Diversity Index", *Ecological Indicators*, Volume 10, no 2, pp. 550-551, 2010.
- [9] R. Demanet, M.L. Mora, M.Á. Herrera, H. Miranda, and J.M. Barea, "Seasonal Variation of the Productivity and Quality of Permanent Pastures in Andisols of Temperate Regions", *J. Soil Sci. Plant Nutr.*, Vol. 15, no. 1, pp. 111–128, 2015.
- [10] V.E. Se'u, P. Karti, and L. Abdullah, "Botanical Composition, Grass Production, and Carrying Capacity of Pasture in Timor Tengah Selatan District", *Media Peternak*, Vol. 38, no. 3, pp. 176–182, 2015.
- [11] Y.U. Hawolambani, H.P. Nastiti, and Y.H. Manggol, "Produksi Hijauan Makanan Ternak dan Komposisi Botani Padang Penggembalaan Alam pada Musim Hujan di Kecamatan Amarasi Barat Kabupaten Kupang", *Jurnal Nukleus Peternak*, Vol. 2, no. 1, pp. 59–65, 2015.
- [12] P. Sanford, B.R. Cullen, P.M. Dowling, D.F. Chapman, D.L. Garden, G.M. Lodge, M.H. Andrew, P.E. Quigley, S.R. Murphy, W. Mc G. King, W.H. Johnston and D.R. Kemp, "SGS Pasture Theme: Effect of Climate, Soil Factors and Management on Pasture Production and Stability Across the High Rainfall Zone of Southern Australia", *Australian Journal of Experimental Agriculture*, Vol. 43, no. 8, pp. 945–959, 2003.
- [13] A.K. Verma, "Necessity of Ecological Balance for Widespread Biodiversity", *Indian Journal of Biology*, Vol. 4, no. 2, pp. 159-160, 2017.
- [14] M. Yusuf, D.P. Rahardja, A.L. Toleng, A. Natsir, and S. Hasan, "Nutrition In-Utero Administration in Pregnant Bali Cows; Its Effect on Metabolite Status", *3<sup>rd</sup> International Conference on Environment Energy and Biotechnology*, Vol. 70, pp. 94-98, 2014.
- [15] Neil, A. J and D.H.L. Rollinson. 1974. *The Requirements and Availability of Livestock Feed In Indonesia*. UNDP/FAO Project INS/72/009.

- [16] E.W. Saragih and N.K. Tero, 2009. "Potential of Three Pastures Different in Manokwari Regency", *Journal of Animal Science* 4 (2):53-60, 2009.
- [17] D.L. Perlman and J. Milder, "Practical Ecology for Planners, Developers, and Citizens", Island Press, 2005.
- [18] R.B. Primack, "Conservation Biology", Translated by J. Supriatna, M. Indrawan, P. Kramadibrata, Indonesian Obor Foundation, Jakarta, 1998.
- [19] A. Hodge, "The Plastic Plant: Root Responses to Heterogeneous Supplies of Nutrients", *New Phytologist*, Vol. 162, no. 1, pp. 9–24, 2004.
- [20] Hyde, Charles E., and Jeffrey M. Perloff. "Can monopsony power be estimated?." *American Journal of Agricultural Economics* 76.5 (1994): 1151-1155.
- [21] A.J. Mwilawa, D.M. Komwihangilo, and M.L. Kusekwa, "Conservation of Forage Resources for Increasing livestock Production in Traditional Forage Reserves in Tanzania", *Afr. J. Ecol.*, Vol. 46, pp. 85–89, 2008.
- [22] B.P. Widyobroto, C.T. Noviandi, and A. Astuti, "Microenvironment Identification and the Feed Availability for Dairy Cows During Dry and Wet Seasons in the Main Dairy Areas of Yogyakarta–Indonesia", *J. Anim. Behav. Biometeorol.*, Vol. 7, no. 2, pp. 86–91, 2020.
- [23] J. St Peter, "Influence of Grazing Management Strategies on Forage Quality/Production and Animal Performance in an Ontario Cow Calf System", University of Guelph, p. 9, 2023.
- [24] A. Lüscher, I. Mueller-Harvey, J.F. Soussana, R.M. Rees, and J.L. Peyraud, "Potential of Legume-Based Grassland–Livestock Systems in Europe: A Review", *Grass and Forage Science*, Vol. 69, no. 2, pp. 206–228, 2014.
- [25] S. Dutta and M.K. Hossain, "Infestation of *Imperata cylindrica* L. and its Impacts on Local Communities in Secondary Forests of Sitakunda Botanical Garden and Eco-Park, Chittagong, Bangladesh," *Int. J. Conserv. Sci.*, Vol. 7, no. 1, pp. 167-180, 2016.
- [26] H. Nahlunnisa, A.M.Z. Ervival and Y. Santosa, "Diversity Plant Species in High Conservation Value (NKT) Plantation Areas Palm Oil in Riau Province," *Conservation Media*, Vol. 21, no. 1, pp. 91-98, 2016.
- [27] E.G., Lamb, N. Kennedy, and S.D. Siciliano, "Effects of Plant Species Richness and Evenness on Soil Microbial Community Diversity and Function," *Plant Soil*, Vol. 338, pp. 483–495, 2011.
- [28] M.I. Rusdin, P. Sri, A.I. Atik, "Study of the Potential of the Central Lore Region for Development of Beef Cattle," *Central Sulawesi Media Journal*, Vol. 2, no. 2, pp. 94-103, 2009.
- [29] Adler, S.A., Jensen, S.K., Govasmark, E. and Steinshamn, H., 2013. Effect of short-term versus long-term grassland management and seasonal variation in organic and conventional dairy farming on the composition of bulk tank milk. *Journal of Dairy Science*, 96(9), pp.5793-5810.
- [30] V.H. Hae, M.M. Kleden, and S.T. Temu, "Production, Botanical Composition and Carrying Capacity of Forage in Native Grassland at Early Dry Season," *Jurnal Nukleus Peternakan*, Vol. 7, no. 1, pp. 14-22, 2020.