Forage potential and carrying capacity of *Indigofera* sp and *Pennisetum purpureum*

N Saking¹, K Ruba¹ and N Qomariyah²,³

¹Technical Implementation Unit of Livestock Breeding and Forage Development, Provincial Livestock and Animal Health Services of South Sulawesi Province, Pucak Village, Tompobulu Sub District, Maros Regency, Indonesia
²South Sulawesi Assessment Institute for Agricultural Technology (South Sulawesi AIAT), Makassar 90243, Indonesia
³Animal Feed and Nutrition Modelling (AFENEU) Research Group, Faculty of Animal Science, IPB University, Bogor 16680, Indonesia

Email: linasach@yahoo.co.id

Abstract. The purpose of this study was to find out the forage potential and cattle carrying capacity under *Indigofera* sp and *Pennisetum Purpureum* forage plants. This study was carried out in Technical Implementation Unit of Livestock Breeding and forage development, Provincial Livestock and Animal Health Services of South Sulawesi Province, Pucak Village, Tompobulu Sub District, Maros Regency, South Sulawesi Province in March 2020. This study used survey method and purposive sampling every 1 m² with a sample distance of 30 until 50 m or an average of 40 meters. This study identified forage in the area of *Indigofera* sp and *Pennisetum purpureum*. Based on the results, the average forage production in *Indigofera* sp and *Pennisetum purpureum* areas was 105,000 kg ha⁻¹. The average cattle carrying capacity in *Indigofera* sp and *Pennisetum purpureum* areas was 0.14 AU.Ha⁻¹.year⁻¹. Thus, it can be concluded that the forage potential under the main forage (*Indigofera* sp and *Pennisetum purpureum*) was very high but had low utilization.

1. Introduction

Development in the livestock sector in South Sulawesi is part of agricultural development as an effort to provide food security and improve the quality of human resources. South Sulawesi is known as a livestock center in Eastern Indonesia. In 2018, the cattle population in South Sulawesi was 1,310,194 heads [1]. Livestock in South Sulawesi is still dominated by cattle which have the potential to be developed by looking at the available resources such as the potential area for forage development. For example, the land around the rice fields is planted with elephant grass (*Pennisetum purpureum*) and *Indigofera* sp. In fact, plants such as legumes thrive under elephant grass but do not get attention. The effect of legume invasion in the elephant grass area is an increase in animal performance and reduced environmental impact [2,3]. However, this advantage is not yet known by breeders. In fact, breeders do not pay attention to the quality and availability of forage, so that livestock cannot consume feed with sufficient nutrition to meet their needs [4].

According to Lascano [5], tropical areas allow the growth of legumes such as Arachis pintoi with high productivity, nutritional value, intercropping potential, and the ability to increase soil fertility. In
addition, legumes are an alternative in intensifying ruminant production in grasslands, improving and diversifying feed, and reducing costs [6]. The most important contribution is improving atmospheric nitrogen and producing forage with better nutritional value and better soil fertility [7]. The main plants, in this case, elephant grass, have the potential to intercrop with legume plants because of the continuous flowering phase and root ability [8] and the high capacity for biological nitrogen fixation in this forage species [7]. In fact, the dwarf elephant grass (*Pennisetum purpureum* cv. Mott) can adapt to grazing because it has a lower level of elevation and a higher proportion of leaves throughout the growing season. This is supported by Almeida *et al.*, (2002) that used dwarf elephant grass (*Pennisetum purpureum* cv. Mott) which showed an average daily increase of more than 1 kg/day in castrated bulls/steers without energy or protein supplementation [9]. However, the agronomic and livestock benefits of invading legumes into superior forage areas such as *Pennisetum purpureum* and *Indigofera* sp are not widely known. In fact, legumes can reduce the need for nitrogen fertilizers and reduce groundwater pollution due to excess fertilization.

The purpose of this study was to find out the forage potential and cattle carrying capacity under *Indigofera* sp and *Pennisetum Purpureum* forage plants.

2. Materials and method
This study was carried out in technical implementation unit of livestock breeding and forage development, provincial livestock and animal health services of South Sulawesi province, Pucak village, Tompobulu sub-district, Maros regency, South Sulawesi province in March 2020.

2.1. Forage sampling
The tools used were stationery, scales, cameras, scissors, knives, ovens and plastic bags. Forage samples were obtained in pasture of technical implementation unit of livestock breeding and forage development. This study used purposive sampling every 1 m² with a sample distance of 30–50 meters or an average of 40 meters. This study identified forage in the pasture of *Indigofera* sp and *Pennisetum purpureum* as well as inventoried forage types, botanical composition, and calculation of forage production. Then, vegetation in each sampling was identified and weighed separately according to groups whether grass, legumes, or weeds.

2.2. Parameters measured
Parameters measured were forage potential in the pasture of *Pennisetum purpureum* and *Indigofera*; and botanical composition (grass, legume, and weeds) as well as carrying capacity. The data and information obtained were descriptively analyzed.

3. Results and discussion
Technical implementation unit of livestock breeding and forage development, provincial livestock and animal health services of South Sulawesi province is located in Pucak village, Tompobulu sub-district, Maros regency which is geographically strategic for the development and breeding of Bali cattle, Buffalo, and Goats. This area has temperatures ranging from 28–30°C with an altitude of 600 m above sea level.

3.1. Forage potential
The use of weeds in pasture land, especially forage under *Pennisetum purpureum* and *Indigofera* sp can help breeders to meet their feed needs. Based on observations on botanical composition and identification of forage species in superior forage areas (*Indigofera* sp and *Pennisetum purpureum*), there are various types of legumes such as *Arachis pintoi*, *Calopogonium mucunoides*, and *Mimosa podica*. Based on the observations, it is seen that there are variations in growth, production and vegetation composition or botanical composition between *Indigofera* sp and *Pennisetum purpureum* areas that can be seen in table 1.
Table 1. Botanical composition and forage production.

| Pasture Type   | Fresh Forage Production | Total (kg.ha\(^{-1}\)) |
|----------------|-------------------------|-------------------------|
|                | Grass (kg.ha\(^{-1}\)) | Legume (kg.ha\(^{-1}\)) | Weeds (kg.ha\(^{-1}\)) |
| Indigofera sp  | 8,160                   | 88,740                  | 5,100                    | 102,000 |
| Pennisetum purpureum | 59,400                     | 43,200                  | 5,400                    | 108,000 |
| Total          | 67,560                  | 131,940                 | 10500                   | 210,000 |
| Average        | 33,780                  | 65,970                  | 5,250                    | 105,000 |

The both type of pasture have almost the same proportion of weeds that was 5%. The Indigofera sp area had more legumes (87%) than the Pennisetum purpureum area (40%). Even the proportion of grass growing in the Indigofera sp area was only 8%, while in the Pennisetum purpureum area was 55%. The proportion of legume under Indigofera sp was higher due to the ability of plants to improve the physical-chemical properties of the soil, and ultimately increase the growth and development of legumes [10]. Indigofera sp provides organic N, P, and C for bacterial populations in the soil [11]. In addition, the proportion of species affects the productivity and abundance of weeds, where the percentage of legumes of 30-40% results in a better proportion of legumes, grass, and weeds [12].

Based on Table 1, the Pennisetum purpureum pasture has a more dominant proportion of grass compared to legumes. The existence of legumes among elephant grass plants is very beneficial because legumes can fixate the nitrogen, thereby increasing soil N levels. The high percentage of grass in the elephant grass area is due to the higher resistance to grazing pressure and bad environments. The combination of grass and legume in the grazing system illustrates great potential because it is not only a high level of production but also environmentally friendly. The presence of legumes has a positive impact on the soil-plant-animal atmosphere system [2,13,14]. and the results of several studies show a positive contribution to the meadow, the amount of biomass produced [15] and forage quality [16]. Forage of grass-legume blends shows an improved balance of protein-energy ratio and an increase in feed digestibility compared to only grass or legume [17–19].

3.2. Carrying capacity
The highest forage production based on fresh ingredients production was found in the Pennisetum purpureum area then Indigofera sp (table 2). Based on the calculation results, the highest carrying capacity was found in the Indigofera sp area that was 0.14 AU.Ha\(^{-1}\). Cattle carrying capacity is related to forage production. If forage production is good, then cattle carrying capacity will increase. The better the forage production, the more livestock that can be grazed in one livestock. The objective of the stocking rate is to balance the forage demand from grazing animals with forage production during the annual forage production cycle [20]. The livestock density that does not consider the forage capacity will inhibit the forage growth so that the forage population with high production and good quality will decrease because they do not have the opportunity to grow.

The obvious benefits of a combination of legume and grass are higher productivity and increased protein self-sufficiency, lower production costs, reduced dependence on fossil energy and N fertilizers, and a lower amount of harmful emissions to the environment (greenhouse gases and nitrates) [21]. Based on the results, the potential of forage under the main forage (Indigofera sp and Pennisetum purpureum) was high. However, this potential received less attention from breeders. Moreover, the forage under the main forage is only weeded out and thrown away. In fact, legume under the main forage is very potential to be used as an animal feed which has a very abundant amount during the rainy season. If used optimally, breeders will not lack forages. Therefore, education is needed to breeders about the various types of legumes that grow under the main forage so that the existence of these legumes can be utilized optimally.
Table 2. Cattle carrying capacity.

| Sampling area        | Fresh forage production (kg) | Carrying capacity |
|----------------------|------------------------------|-------------------|
| Indigofera sp        | 102,000                      | 7.1               |
| Pennisetum purpureum| 108,000                      | 7.5               |
| Average              | 105,000                      | 7.3               |

4. Conclusion

Based on the results, it can be concluded that: the average forage production in *Indigofera* sp and *Pennisetum purpureum* pasture was 105,000 kg ha\(^{-1}\), botanical composition of fresh forage in *Indigofera* sp area showed that the grass production was 8,160 kg ha\(^{-1}\) (8%), legume was 88,740 kg ha\(^{-1}\) (87%), and weeds was 5,100 kg ha\(^{-1}\) (5%). In *Pennisetum purpureum* area, the grass production was 59,400 kg ha\(^{-1}\) (55%), legume was 43,200 kg ha\(^{-1}\) (40%) weeds was 5,400 kg ha\(^{-1}\) (5%). The average cattle carrying capacity in *Indigofera* and *Pennisetum purpureum* pasture was 0.14 AU Ha\(^{-1}\) year\(^{-1}\). The forage potential under the main forage (*Indigofera* sp and *Pennisetum purpureum*) was very high but had low utilization.

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