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FORAGE PRODUCTION ESTIMATION AND LAND CARRYING CAPACITY OF FORAGE PLOTS AT UNIVERSITAS ISLAM KUANTAN SINGINGI, RIAU, INDONESIA

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Abstract

Forage availability is a major determinant of sustainable ruminant production, particularly in tropical production systems where livestock depend heavily on fresh forage. This study aimed to estimate fresh forage production and determine the carrying capacity of forage plots at Universitas Islam Kuantan Singings (UNIKS), Riau, Indonesia. The research was conducted in the UNIKS forage field using a quadrat sampling approach. Three sample plots were established across the field, and all fresh forage within each plot was harvested and weighed. The observed fresh forage weights were then used to estimate production per hectare and annual production, while carrying capacity was estimated based on standard livestock feed requirements. The results showed substantial variation among sampling points. Sample 1 produced 353 g of fresh forage and had the highest estimated annual production of 470.7 t ha−1 year−1. Sample 2 produced 64.5 g and had the lowest estimated production of 86.0 t ha−1 year−1, while Sample 3 produced 254 g and had an estimated production of 338.7 t ha−1 year−1. The estimated carrying capacity was 15 heads for the highest-producing plot, 2 heads for the lowest-producing plot, and 11 heads for the moderate plot, with an average of 9 heads per study unit. The variation was associated with differences in soil fertility, sunlight intensity, soil moisture, plant density, and weed competition. The findings indicate that UNIKS forage land has considerable potential as a feed resource, but improved land management and additional sampling are needed to obtain more robust estimates and improve forage productivity.

Keywords: forage production; carrying capacity; ruminants; quadrat sampling; tropical forage

INTRODUCTION

Forage is the principal feed resource for many ruminant production systems and its availability directly influences livestock productivity and the sustainability of farm operations. In tropical regions, forage production can be high, but the quantity and quality of available biomass may vary considerably according to environmental conditions, plant composition, season, soil fertility, and management practices. Consequently, reliable estimation of forage production is important for determining how many animals can be supported by a given area without placing excessive pressure on the available feed resource.

Carrying capacity represents the ability of a forage resource to support livestock based on the relationship between forage supply and animal feed requirements. Recent studies in Indonesia have demonstrated that forage production and carrying capacity can differ substantially between locations and management conditions. For example, a study of an integrated forage laboratory in Kediri reported a carrying capacity of 7.878 animal units per hectare during the dry season, based on dry-matter production and livestock requirements. Other studies have similarly used quadrat-based field observations and forage production measurements to estimate the carrying capacity of forage resources.

Universitas Islam Kuantan Singingi (UNIKS) has forage plots that can function as a potential feed resource and as a learning and research area for animal science students. However, differences in field conditions may cause forage production to vary between sampling locations. Without quantitative information on forage production, decisions concerning livestock stocking and sustainable utilization of the land may be less accurate.

Therefore, this study aimed to: (1) measure fresh forage production in the UNIKS experimental forage plots; (2) estimate forage yield per hectare and annual production; (3) determine the carrying capacity of the forage land for ruminant livestock; and (4) identify factors that may contribute to variation in forage production among sampling points.

1. MATERIALS AND METHODS

1.1 Study Site

The study was conducted in the forage field of Universitas Islam Kuantan Singingi (UNIKS), Riau, Indonesia. The field represents a tropical forage-growing environment in which differences in soil and vegetation conditions may influence biomass production.

1.2 Sampling and Data Collection

A quadrat sampling method was used. Three sample plots were placed across the forage field to represent different points within the study area. All fresh forage contained within each sample plot was harvested and weighed. The measured fresh weights were subsequently used to estimate forage production per unit area and annual production.

1.3 Estimation of Forage Production

Fresh forage production was estimated by converting the fresh weight obtained from each sampling unit to an equivalent production per hectare and annual production. The study therefore focused on fresh forage production rather than laboratory-determined dry-matter yield. The three observed sampling values were 353 g, 64.5

g, and 254 g for Samples 1, 2, and 3, respectively.

1.4 Estimation of Carrying Capacity

Land carrying capacity was estimated from the available forage production and standard livestock feed requirements. The resulting values were expressed as the estimated number of ruminant livestock heads that could be supported by the respective study units. Because the source dataset does not specify the exact livestock species, body-weight standard, utilization factor, or complete equation used in the calculation, these assumptions should be stated explicitly in the final conference template if the organizers require the calculation formula.

2. RESULTS AND DISCUSSION

2.1 Fresh Forage Production

Fresh forage production differed markedly among the three sampling points. Sample 1 recorded the highest fresh forage weight at 353 g, corresponding to an estimated annual production of 470.7 t ha−1 year−1. Sample 2 recorded the lowest fresh forage weight at 64.5 g, corresponding to 86.0 t ha−1 year−1. Sample 3 recorded 254 g of fresh forage and an estimated annual production of 338.7 t ha−1 year−1.

Sampling point	Fresh forage weight (g)	Estimated production (t ha−1 year−1)	Relative production
Sample 1 (highest)	353	470.7	Highest
Sample 2 (lowest)	64.5	86.0	Lowest
Sample 3 (moderate)	254	338.7	Moderate

Table 1. Fresh forage production and estimated annual production at the three sampling points.

The difference between the highest and lowest estimated production indicates that forage productivity was not uniform across the study area. This finding is important because a single average value may conceal substantial spatial variation in the actual feed resource. Field studies in tropical forage systems also report that forage production and carrying capacity depend on vegetation composition, soil characteristics, moisture, and management.

2.2 Land Carrying Capacity

The estimated carrying capacity followed the same general pattern as forage production. The highest-producing plot was estimated to support 15 livestock heads, the lowest-producing plot 2 heads, and the moderate plot 11 heads. The average carrying capacity across the three sampling points was 9 heads per study unit.

Sampling condition	Estimated carrying capacity (heads)
Best plot	15
Lowest plot	2
Moderate plot	11
Average	9

Table 2. Estimated carrying capacity of the forage plots.

The relationship between forage production and carrying capacity is logical because a greater quantity of usable forage provides a larger feed resource for livestock. However, carrying capacity should ideally be calculated from dry-matter production and clearly stated animal feed requirements rather than fresh weight alone. Published Indonesian studies have used dry-matter production and animal-unit requirements for carrying-capacity estimation, emphasizing the importance of standardizing the feed basis when comparing sites.

2.3 Factors Affecting Production Variation

The observed variation among sampling points may be explained by differences in soil fertility, sunlight intensity, soil moisture, plant density, and weed competition. These factors can influence plant growth, biomass accumulation, and the ability of forage plants to compete for water, nutrients, and light.

Soil fertility affects nutrient availability for forage growth, while sunlight provides the energy required for photosynthesis. Soil moisture is particularly important in tropical forage systems because water availability can influence vegetative growth and biomass accumulation. Plant density may increase total biomass when suitable species are established at adequate density, but excessive density can also increase competition among plants. Similarly, weeds may reduce forage productivity through competition for nutrients, water, light, and growing space.

The results therefore suggest that targeted management could improve the productivity and carrying capacity of the UNIKS forage field. Potential management measures include improving soil fertility, maintaining adequate soil moisture, controlling weeds, and managing plant density. Nevertheless, the claim that management can increase carrying capacity by up to sevenfold should not be treated as a measured experimental result of this study because the present dataset did not include a controlled management treatment.

3. CONCLUSION

The forage plots at Universitas Islam Kuantan Singingi showed substantial variation in estimated fresh forage production and carrying capacity. The highest estimated annual forage production was 470.7 t ha−1 year−1, while the lowest was 86.0 t ha−1 year−1; the moderate plot produced 338.7 t ha−1 year−1. The corresponding estimated carrying capacities were 15, 2, and 11 livestock heads, respectively, with an average of 9 heads per study unit. The variation among plots was associated with differences in soil fertility, sunlight intensity, soil moisture, plant density, and weed competition. Overall, the UNIKS forage land has potential as a ruminant feed resource, but additional sampling and more detailed forage-quality measurements are needed to improve the reliability of the carrying-capacity estimate.

4. RECOMMENDATIONS

Future research should increase the number of sampling plots and repeat measurements across different seasons to obtain a more representative estimate of forage productivity. Forage dry-matter content, botanical composition, crude protein, fiber fractions, and other nutritional indicators should also be measured. The carrying-capacity calculation should report the animal unit or livestock species, assumed body weight, daily dry-matter requirement, and forage utilization factor so that the calculation can be reproduced and compared with other studies.

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