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05. EVALUATION OF AVAILABILITY AND QUALITY OF FORAGES AT LIMAU MANIS CAMPUS OF ANDALAS UNIVERSITY, PADANG, WEST SUMATRA

Khalil

Department of Nutrition and Feed Technology, Faculty of Animal Science, Andalas University, Kampus Limau Manis Padang. Email: khalil@faterna.unand.ac.id

Abstract

Ruminant livestock raised at teaching farm unit of Andalas University, West Sumatra is almost entirely dependent on forage feeds. Forages are often of poor quality, usually high in fiber and deficient on protein and minerals. The present research on assessment of availability and quality of forage sources was aimed to define appropriate stocking rate of beef cattle raised at teaching farm of the Andalas University of West Sumatra. Three areas of forage sources located at campus were selected as research sites, i.e.: teaching farm pasture, palm oil and teak wood plantations. Samples of forages in fresh form were collected in 5 different sampling points of each site by using quadrant of 0.5x0.5 m in size. The fresh samples were weighed and then sorted by plant species for identification of botanical composition. The samples were then remixed, dried and ground for chemical analysis. Parameter measured included forage mass yield, botanical composition, carrying capacity, DM and nutrient content of CP, CF, crude ash and macro minerals of Ca, P, Mg, K, Na and S. Results shown that production of forages mass both in fresh and dry form harvested from teaching farm pasture differed not significantly ($P>0.05$) with those from palm oil and teak wood plantations. The production of forages mass in DM form from the pasture of teaching farm, palm oil and teak wood plantation areas were found of about 24.1, 18,9 and 27.8 t/ha/year with carrying capacities of about 4.5, 3.5 and 5.1 animal unit/ha, respectively. The quality of forages from the pasture in term of CP content (11% DM) was equal to those of from teak wood plantation (11.5%), but significantly lower ($P<0.05$) than those of from palm oil plantation (18.2%). Ca content ranged between 7.0 to 7.7 g/kg. The highest mineral content was Na of about 11-14 g/kg, followed by Mg (8.7-9.5 g/kg), K (8.3-8.9 g/kg DM), while S content ranged between 3.8 to 4.5 g/kg DM. Mineral P was found the lowest, varied from 0.5 to 1.3 g/kg DM. Forages harvested at teak wood plantation showed the lowest P content of about 0.5 g/kg ($P<0.05$). Based on total wide of each sites, forages mass from pasture, palm oil and teak wood plantation could support feed for about 13.4, 69.9 and 20.6 AU, respectively, so that the stocking rate of beef cattle raised at the faculty teaching farm could be increased by about 7-8 times, if the potency of the forages available was optimally exploited.

Key words:forage mass production, forages quality, carrying capacity.

INTRODUCTION

The Faculty of Animal Science of Andalas University which is located eastern part Padang city of West Sumatra possesses a livestock teaching farm for raising different kinds of livestock animals. The teaching farm which is occupied of about 25 ha and located at upland area of Limau Manis of Pauh subdistrict ought to be an ideal location for raising ruminant livestock, especially beef cattle.The farm which was mainly assigned to serve education and research is potentially developed as a center for beef cattle production in West Sumatra. Itwill be not only as a potentially source of

income for the faculty, but also supports the government in achieving self-sufficiency program in meat in the year 2014.

The farm has been completely set up with stalls, animal handling facilities and pasture. In the fact, the number of beef cattle raised at present time is very limited in compare to the availability of stalls and other facilities. The present capacity of stalls are available for about 100 head of beef cattle, but the present number of cattle raised are only about 20 heads (Infitria, 2012). The main constraint in raising beef cattle is the limited availability of forages as the main feed of cattle. The farm possesses limited pasture, which is only 3 ha from the total of about 25 ha land area occupied by the farm (Infitria, 2012). Productivity of pasture and the quality of forages are also presumably low due to lack of management. The pasture was planted with two kinds of high productivity grass of *Pennisetum purpureum* and *Brachiaria decumbens*, but the grass grown not uniform and there were significant invasion of weeds.

The availability and quality of fodder feed might be enhanced byimproving of pasture management and exploiting forages sources outside the farm within campus area. Most of campus area which occupied of about 479 ha (UNAND, 2007) are allocated as open green areas. These areas were planted with various perennial trees and crop plantations for several purposes, i.e. soil erosion control, land conservation, field laboratory for study of biodiversity and crop estate production and management. The inter row areas of these tree crops are covered with vegetation comprising of native grass, legumes, broadleaf species and ferns which can be utilized as forage for beef cattle production in order to increase stocking rate of teaching farm.

The most potential forages sources for teaching farm are palm oil (*Elaeis guineensis*)and teak wood (*Tectona grandis* L) plantations which occupied of about 20 and 4 ha, respectively. These plantation areas are located in adjacent to the teaching farm at the southern part of campus, a long road side of main entrance of the University.Such favorable site position and accessibility lighten in exploiting and utilizing the forages with*cut and carry* feeding system. In the plantations, plants that grow in the inter rows are considered weeds. Chemicals are used regularly to control weed growth so that the cost of weeding is quite substantial. Moreover, constant application of chemicals will alter the ecological profile of vegetation and soil, reduced biodiversity in the soil and plant growth can be affected.According Hassan & Sani (1991) there were about 60 to 70 plant species growing under the young plantation crops and the number decline to 20 to 30 species under older trees. Out of these, about 70% of these species are palatable for ruminant animals.

The present research was aimed to study the availability and quality of forage sources from three different sites of pasture, palm oil and teak wood plantations located at Limau Manis campus to define a potential stocking rate of beef cattle raised at livestock teaching farm of Andalas University.

MATERIALS & METHODS

Study Sites and Sampling Points

The study was initiated by collecting of forages samples from three different sites at Limau Manis campus area of Andalas University, Padang West Sumatra in September 2012. First was teaching farm pasture with total area of about 3 ha. The pasture which was managed by the Faculty of Animal Science consisted of 12 paddocks

with different sizes. The second was palm oil plantation with the total area of about 20 ha. The oil palm plantation was located at the southwestern part of campus in adjacent to the faculty teaching farm. The palm oil crops were about 4 years old with the total production of about 4 ton/month. The third was teak wood plantation with total area of about 4 ha and located at western campus in adjacent to palm oil plantation. The teak wood trees were about 10 year old with the mean canopy height of about 10 m.

Forage samples at pasture were collected at 8 paddocks from the total of 12 paddocks available due to relatively high variability in plant growth and land topography. At each paddock were determined 5 sampling points by dividing the paddock area proportionally into 5 blocks by considering land contour, plant condition and accessibility. Samples at palm oil and teak wood plantations were collected at 5 sampling points each. Sampling points were determined by dividing the areas proportionally into 5 blocks by considering land contour and accessibility.

Sample Collection and Analysis

Samples of forages were collected by using quadrats plate mater of 0.5 x 0.5 m in size which has been also used by Parlak et al. (2011) for estimation of forage availability. Plate meter was randomly placed at each sampling points. Plant materials in plate meter were cut at ground level and placed in individual plastic bag. The fresh samples were weighed and then separated into species and then weighed for determination of botanical composition. All samples of each sampling point were mixed and chopped. Representative samples of about 50 g were dried in a forced draught oven at 60ºC for 24 hours and ground in meal form prior to analysis for dry matter (DM), crude ash, crude protein (CP), crude fiber (CF) and macro minerals of Ca, P, K, Na, Mg and S.

DM and nutrient contents of crude ash, CP and CF were determined using the procedure described by AOAC (2005). Samples for mineral analysis were prepared by wet digestion method using concentrated sulfuric acid and hydrogen peroxide. The concentration of Ca, K, Na, Mg, P and S were determined using an atomic absorption spectrophotometer (Fritz and Schenk, 1979). All analysis results were reported on DM basis.

Forage mass production in ton/ha/year was estimated using formula: {(fresh weigh per sampling/1000) x 40} x (360:40)days. Total forage mass production (ton/year) was calculated by multiplying forage mass production per hectarewith total area in hectare. Daily forage mass production was calculated by dividing total forage mass production with 360 days, while forage mass production in DM was obtained by multiplying forage mass production in fresh form with DM content. Livestock carrying capacity was estimated using method described by Reksohadiprodjo (1985) and Damry (2009). One animal unit (AU)is equal to one beef cattle with average body weight of 500 kg and daily feed requirement in DM form of about 3% body weight, so that carrying capacity was calculated by dividing daily forage mass production in DM form in kg with daily feed requirement of 15 kg DM.

Statistical Analysis

Data on forage mass production, carrying capacity and nutrient and mineral content were subjected to analysis of variance (ANOVA) in completely random design of 3x5 consistingof 3 forage source sites and 5 sampling points as replicates.Duncan's

Multiple Range (DMRT) was applied to separate means. Differences were considered significant at P<0.05 (Steel et al., 1997).

RESULTS AND DISCUSSION

Biomass Production and Quality

The mean weight of samples in fresh form harvested from three forages sources at campus area of Andalas University ranged from 200 to 280 g/sampling, while forages mass production in DM form ranged from 19-28 tons/ha/year with the mean carrying capacity of about 3.5-5.1 AU/ha (Table 1). The biomass yields from these selected forage source sites at campus area were much higher than that from native pasture. Chen et al. (1991) reported that productivity of native pasture has been estimated conservatively to range from 3 tons/ha/year, while carrying capacity of nature grass land in Poso district of Central Sulawesi was about 0.61-0.65 AU/ha (Damry, 2009).

DM yield and carrying capacity of teaching farm pasture of about 24.1 tons/ha/year and 4.5 AU/ha, respectively, were found lower than that of teak wood plantation and not better than that of palm oil plantation, even though the data was statistically not significantly difference (P>0.05). In term of crude protein and crude fiber content, the quality of forages from teaching farm pasture was equal to that from teak wood plantation, but the crude protein content of about 11% was found significantly lower (P<0.05) that that from palm oil plantation (18.2%) (Table 2). According to Damry (2009) protein was very important nutrient in ruminant animals to support the optimal development and function of microbial activities in rumen. The grass grown not uniform and the pasture was severely invaded by weeds due to lacks of management. These facts were proved by the data of botanical composition (Table 3). As shown in Table 3, the kinds of plant species grown in the pasture were found the highest variation amongs the three research sites.In addition, the percentage of improved grass of *Brachiaria decumbens* was only 5% in compare to native species of *Cyperus rotundus* of about 19% (Table 3). Attempts should be undertaken to improve pasture productivity and yield quality through weed control, improvement of soil fertility grazing management and renovation grass species.

Teak wood plantation area produced the highest biomass yields in form both fresh and dry, followed by teaching farm pasture and palm oil plantation. On the other hand, the forages from teak wood plantation were found the lowest quality due to the highest content of crude fiber (45.5%) and crude ash (12.1%) (Table 1). Vegetation covered teak wood plantation area were mostly mature and more variety in species due to lack of weed control. There were 4 species dominantly grown in the teak wood plantation area: *Axonopus compressus* (40%), *Imperata cylindrica* (16%), *Cyperus rotundus* (19%) and *Melastoma malabatricum* (13%) (Table 3).

Crude fiber and crude ash content increased with maturation (Tolunay et al., 2009; Haddi et al., 2003; Mountousis et al., 2008), while protoplasm compound like crude protein decreases (Parissi et al., 2005). In addition, stem ratio increases more than leaf ratio over time with plant development (Frost et al., 2008). Crude fiber content of forages harvested at teak wood plantation was equal to the fiber content of grass from native grass land in Central Sulawesi as reported by (Damry, 2009). Feeding of the native grass on Bali cattle gave poor body weight gain of about 0.25-0.50 kg/head/day (Damry et al., 2008).

Forages from palm oil plantation showed biomass yield of about 19 tons DM/ha/year with mean carrying capacity of 3.5 AU/ha (Table 1). The availability of forages under palm oil crops managed by the Faculty of Agriculture and its carrying capacity were the lowest among the research sites ($P<0.05$). In addition to lower biomass yield in fresh form (71.7 tons/ha/year), forages from palm oil contained lowest dry matter of about 25% (Table 1). The carrying capacity of forages harvested from the campus palm oil plantation was slightly higher than that reported from Malaysia. Research results in Malaysia reported by Chen et al. (1991) showed that in young palm oil, 3 steers/ha can be kept for two years and the stocking rate should be reduced to 2 and 1 when the canopy is closed. The higher forage mass production of palm oil plantation at Andalas University due to lack of weed control, especially at the plantation area located far from the main entrance road of the University.

In term of quality, forage mass from palm oil contained the highest in crude protein (18%) ($P<0.05$) and lowest in crude fiber of 36.5% (Table 1). Nutritive values of forages from palm oil were higher than that of native grass. The crude protein content of native grasses on offer ranges from 6.7 to 11.4% (Lane & Mustapa, 1983). It is quite common that the animals through selective grazing may consume forages under palm oil crops with 16% crude protein or even higher, especially when grazing broadleaves and legumes (Chen et al. 1991). In addition, vegetation grown under palm oil trees were seen fresh and green as direct effect of regular application of fertilizer for tree crops. Kinds of plant species grown under palm oil were also found not so much as found under teak wood plantation. Botanical composition was dominated by relatively high palatable forages of *Axonopus compressus* and young *Imperata cylindrica* (Wong & Chin, 1998) with the mean percentages of about 32 and 50%, respectively (Table 3).

Macro mineral contents of forages were presented in Table 2. There were no statistically differences in mineral content of forages from different sources. Ca content ranged between 7 to7.7 g/kg. The findings of present study revealed that Ca content of forages on campus were considered high, while optimum level of Ca in plants ranged from 4 to 6 g/kg (Georgievskii, 1982; Khan, et al., 2009). On the other hand, in compare to minimum level of Ca in cattle diet of about 35 g/kg to fulfill its maintenance and production requirement (NRC, 1996), the optimum Ca content of forages should range of 17 to 42 g/kg (Sultan et al., 2008).

As shown in Table 2, the highest mineral content was Na of bout 11-14 g/kg, followed by Mg (8.7-9.5 g/kg) and K (8.3-8.9 g/kg DM). Mineral P was found the lowest, varied from 0.5 to 1.3 g/kg DM. This variation might be due to available P in the soil. DM. These results were coincided with the mean P content of tropical forages. The P content in tropical grasses varied from 0.2 to 0.6 g/kg of plant dry matter (Skerman & Riveros, 1990). Forages harvested at teak wood plantation showed the lowest P content of about 0.5 g/kg which was presumably due to P deficiency in the soil.

Stocking Rate

Based on total area of research sites, forages from teak wood plantation with total area of about 4 hectares were available about 403.6 tons/year in fresh form or about 309 kg/day in dry matter form. These forage mass might supply feed for about 20.6 AU or 20.6 heads of mature beef cattle. Teaching farm pasture with total area of about 3 hectares might produce forages of about 201 kg in dry matter from per day, which was

only enough to feed about 13.4 AU. This estimated carrying capacity was nearly coincided with unit number of cattle raised at the teaching farm during the research. There were about 20 heads of local beef cattle (Bali cattle) with different ages and body weight. The mean body weight was of about 300-350 kg/head.

Even though palm oil plantation gave the lowest yield of forage mass per hectare both in fresh (71.7 tons) and dry matter form (18.9 tons) (Table 1), the potential forage available at palm oil plantation with total area of about 20 hectares was estimated about 1434 tons in fresh form per year or 1048 kg/day in dry matter form. These forage mass might use to feed about 70 AUor 70 head of beef cattle per day. Therefore, if the potency of feed from the three forage sources of pasture, palm oil and teak wood plantations located at Limau Manis campus, the number of beef cattle raised at teaching farm of the Faculty of Animal Science of Andalas University might be increased to about 100 heads. These results were in line with the potential stocking rate of beef cattle raised at teaching farm of the Faculty of Animal Science, Andalas University, reported by Infitria (2012)

CONCLUSIONS

The availability of forages from teaching farm pasture was very limited and could only support about 13.4 AU. The stocking rate of the farm might be increased by using underutilized forage resources available at palm oil and teak wood plantations located in adjacent to the farm. Biomass yield of forage from teak wood plantation was higher and its quality was equal to that from teaching farm pasture, while the forages from palm oil showed the highest total biomass yield and the best quality. If the potency of the forages available in palm oil and teak wood plantations was optimally exploited, the stocking rate of beef cattle raised at the faculty teaching farm could be increased about 7-8 times from the present capacity.

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Table 1. Biomass production, carrying capacityand quality of three forage sources located at Limau Manis campus of Universitas Andalas

No.	Parameters	Teaching farm pasture	Palm oil plantation	Teak wood plantation
1.	Fresh sampling weight, g/sampling	$222.7^{ab} \pm 58.6$	$199.2^{b} \pm 69,3$	$280.3^{a} \pm 78.2$
2.	Fresh forage mass yield, t/ha/year	$80.2^{ab} \pm 23.7$	$71.7^{b} \pm 25.0$	$100.9^{a} \pm 28.2$
3.	DM content, %	29.2 ± 6.1	25.5 ± 4.5	27.7 ± 3.6
4.	DM yield, t/ha/year	$24.1^{ab} \pm 10.0$	$18.9^{b} \pm 9.3$	$27.8^{a} \pm 8.2$
5.	Carrying capacity, AU/ha	4.5 ± 1.9	3.5 ± 1.7	5.1 ± 1.5
6.	Proximate analysis, % DM:			
	- Crude protein, %	$11.1^{b} \pm 4.3$	$18.2^{a} \pm 4.2$	$11.5^{b} \pm 1.4$
	- Crude fiber, %	42.6± 3.2	36.5 ± 7.4	45.5 ± 6.2
	- Crude ash, %	8.8 ± 1.1	9.1 ± 3.5	12.1 ± 2.3

Note: Means in the same row with different superscript differ significantly (P<0.05).

Table 2. Macro mineral content of forages from three different sources located at campus area of Andalas University

No.	Minerals	Teaching farm pasture	Palm oil plantation	Teak wood plantation
1.	Ca	7.7 ± 1.3	7.0 ± 0.8	7.7 ± 1.1
2.	P	$1.3^{a} \pm 0.2$	$1.0^{a} \pm 0.3$	$0.5^{b} \pm 0.2$
3.	Mg	9.5 ± 1.1	8.7 ± 1.4	9.0 ± 1.2
4.	K	8.8 ± 0.6	8.9 ± 1.3	8.3 ± 1.8
5.	S	4.3 ± 0.2	3.8 ± 0.3	4.5 ± 0.3
6.	Na	11.3 ± 1.8	14.8 ± 8.2	13.6 ± 7.9

Note: Means in the same row with different superscript differ significantly (P<0.05).

Table 3. The botanical composition of forages from three different locations at campus of Andalas University (%)

No.	Plant species (local name)	Teaching farm pasture	Palm oil plantation	Teak wood plantation
1.	*Pennisetum purpureum* (rumput gajah)	39.7	-	-
2.	*Brachiaria decumbens* (rumput bede)	5.3	-	-
3.	*Axonopus compressus* (rumput pahit)	8.6	31.9	40.1
4.	*Imperata cylindrica* (ilalang)	7.8	50.4	15.6
5.	*Cyperus rotundus*(teki)	18.9	8.5	19.0
6.	*Melastoma malabatricum* (sikaduduak)	0.5	2.9	12.9
7.	*Cyclosorus parathelyptens* (pakis)	5.6	-	8.1
8.	*Mimosa pudica* (putri malu)	3.7	-	2.9
9.	Others	9.9	6.3	1.4