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ADDRESS
Room 108 Faculty of Animal Science, Jenderal Soedirman University (UNSOED)
Dr Suparno Street No 60, Po Box 110, Purwokerto, Central Java, Indonesia
Telp./Fax. +62-281-638792
Email: redaksijap@yahoo.com; Website: www.animalproduction.org

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FROM THE EDITOR

Greetings,

Welcome to the first issue of Journal of Animal Production (JAP) in 2011. Let me express my deepest gratitude to all reviewers, editors, authors as well as readers for your supports and contributions. Although the time passes, our objective remains that is to publish research findings on all aspects of animal production, including (1) production technology and management, (2) breeding and reproduction, (3) feed, feeding & nutrition, (4) socio-economic aspect of animal production, and (5) post-harvest physiology and technology. In order to facilitate easier access to all our articles, starting this year we have migrated our website to www.animalproduction.net. All articles from the first volume in 1999 have been uploaded to the new website and can be downloaded freely. Furthermore, readers can easily search our articles using Google Scholar.

In this issue, we provide 10 articles covering poultry and ruminants feeding and nutrition, molecular investigation on sheep, reproduction of Bali and Sumatra cattle in Indonesia, viability of semen, isolation of lactic acid bacteria from goat milk, and inter-relationship between body measurements and prices of sheep in Nigeria.

At last but not least, we believe that the Journal of Animal Production will continue to make significant contribution to the advancement of knowledge and technology in the area of animal production to provide sufficient food products to meet people's demand worldwide, particularly those in tropical countries.

Yours sincerely,

Mas Yedi Sumaryadi
Editor in Chief

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Rotational Grazing System for Beef Cows on Dwarf Elephantgrass Pasture for Two Years after Establishment

M Mukhtar[1)] and Y Ishii [2)]

[1)]**Animal Technology Division, Faculty of Agriculture, Gorontalo State University**
Jalan Jenderal Sudirman No. 6 Kota Gorontalo Telp. 085240672600, Indonesia
[2)]**Division of Grassland Science, Faculty of Agriculture, University of Miyazaki, Miyazaki 889-2192, Japan**
***Corresponding author email: mmukhtarm@yahoo.com**

Abstract. An intensive rotational grazing system for dwarf and late heading (DL) elephant grass (*Pennisetum purpureum* Schumach) pasture was examined in a summer period for two years following establishment. Four 0.05 of DL elephant grass pastures (20×25 m) were established on May 2003. They were rotationally grazed for 1 week, followed by a 3-week rest period by three breeding or raising beef cattle for three and six cycles during the first and second years of establishment respectively. Before grazing, the plant height, leaf area index and the ratio of leaf blade to stem were at the highest, while tiller number increased and herbage mass tended to increase, except for the first grazing cycle both two years and for one paddock in the second year. Herbage consumption, the rate of herbage consumption and dry matter intake tended to decrease in three paddocks from the first to the third cycle in the first year, but increase as grazing occurred in the second year. Dry matter intake averaged 10.2-14.5 and 15.4–23.2 g DM/kg/live weight (LW)/day over the four paddocks in the first and second year, respectively, and average daily gains were 0.09 and 0.35 kg/head/day in the first and second year respectively. The carrying capacities were estimated at 1,016 and 208 cow-days (CD)/ha (annual total 1,224 CD/ha) in the first year and 1,355 and 207 CD/ha (annual total 1,562 CD/ha) in the second year. Thus, DL elephant grass pasture can expand the grazing period for beef cows for the following two-year establishment.

Key Words: dwarf elephant grass, herbage mass, plant characters, rotational grazing

Introduction

Rotational grazing is a method of intensive grazing management that allows livestock a continuous opportunity to consume fresh forage at an active growth stage. The grazing system and associated management practices can substantially influence the grazing patterns and the use of a pasture (Chacon et al., 1978). The selection of defoliated herbage is probably the most important effects of grazing animals on pasture, with consequences such as reduction in leaf area combined with that in carbohydrate storage, tiller development, leaf and stem growth (Chaparro et al., 1996; Sollenberger and Burns, 2001).

Beef calf breeders are eager to obtain a stable source of self-supplying food that protects against cattle disease, which will probably come from imported herbage. From the previous research, it was known that dwarf elephant grass (*Pennisetum purpureum* Schumach*)* of the late-heading type (DL) has a higher percentage of leaf blades than the other normal and dwarf varieties (Mukhtar, 2006). DL elephant grass is also the most suitable for grazing use among examined elephant grass varieties because it is shorter and has a higher percentage of leaf blades than the other varieties (Mukhtar and Ishii, 2007).

In a preliminary study, it was found that 0.05 ha of DL elephant grass pasture had the capacity to graze three beef cows for a week, with approximately a one-month rest period, without concentrated feeding in the hot summer season, in the following 2 years of establishment (Mukhtar, 2007). However, to enhance our understanding of rotational grazing on DL elephant grass pasture, it is important to identify such variables as herbage consumption, carrying capacity and sward management techniques to increase the live

weight (LW) of beef cows, and to maintain the live weight (LW) of breeding beef cows. There have been several studies reporting the high forage quality of dwarf elephantgrass in Florida USA (Woodard and Prine, 1991; Sollenberger et al., 1993; Williams and Hanna, 1995), Georgia, USA (Hanna and Monson, 1988; Hanna et al., 1993), Taiwan (Hsu and Hong, 1993) and Thailand (Tudsri et al., 2002a, 2002b).

In this study, a rotational grazing system for DL elephant grass pasture was examined without feeding cattle with concentrate or supplied roughage to determine herbage consumption, carrying capacity and daily gain of breeding and raising beef cows on DL elephant grass pasture for the following 2 years of establishment.

Materials and Methods

Pasture management

The research was carried out in the Experimental Field, Miyazaki University, during rainy season from May 2003 to November 2004. The dwarf and late heading variety of elephant grass (*Pennisetum purpureum* Schumach) were obtained from the Dairy Promotion Organization (DPO), Thailand. The area of each paddock was 0.05 ha, and four paddocks were established for rotational grazing by transplanting rooted tillers of elephant grass at about 20 cm in length. The elephant grass was sown at the density of two plants per m^2, in a 1×0.5 m pattern. Each paddock was fertilized with 20 g N/m^2/year of chemical compound fertilizer ($N:P_2O_5:K_2O$ = 13:13;13%) applied in four split applications every year. Fertilization was conducted at pre-grazing and post-grazing. Each paddock was connected to the watering facility and trees for shelter via a road.

Grazing design and animal measurements

Three breeding beef cows (not pregnant) were used for the rotational grazing and the grazing schedule was totally 3 cycles in 2003 and 6 cycles in 2004. The average live weight (LW) during rotational grazing was 446.9 kg/head and 378.6 kg/head in 2003 and 2004 respectively. LW was measured at 11.00 hours when cows moved to a different paddock. Each paddock was grazed 1-week from the first to third cycles in 2003 and from the first to sixth cycles in 2004. The rest period and the length of the last grazing cycle was determined depending on the herbage mass in each paddock in both years , because the pre-grazing growth for the last cycle was variable among paddocks due to the air temperature becoming colder overtime. No concentrates were given to the beef cows, but they did have ad libitum access to mineral supplements during the rotational grazing. Paddocks were not moved throughout the experimental period.

Plant measurements

Six DL elephant grass plants were sampled by using the line-transection method both before and after grazing in each paddock. Herbage mass before and after grazing was determined by cutting plants at 10 and 30 cm above the ground level. The measured characters were tiller number, plant height, leaf area index and dry matter (DM) mass of leaf blades, stem with leaf sheath and dead parts. Plant heights before and after grazing and tiller number before grazing were determined in four set rows (20 and 40 plants in 2003 and 2004 respectively) in each paddock.

Calculation of herbage production, herbage consumption, herbage allowance, DM intake and carrying capacity

Herbage production (g DM/m^2) during the grazing period was estimated by the sum of the crop growth rate (CGR) within a certain grazing period, in which the difference between herbage mass before and after grazing in the following grazing periods were divided by the rest period. Herbage consumption by beef cows (g DM/m^2) was estimated by the total difference between herbage mass before and after grazing, and herbage production during the grazing period. Herbage allowance (kg DM herbage mass per 100 kg LW) was calculated by the herbage mass before grazing, divided by the

total LW of the grazing cows. DM intake (g/kg LW/day) was calculated by the herbage consumption during the grazing period divided by stocking density, cow LW and grazing period (days). Carrying capacity (cow-days, CD) was calculated by the product of stocking density (No. per ha) and grazing period (days), corrected for cow LW at 500 kg.

Statistical analysis

Statistical significance with respect to the differences in the mean value of plant characters in DL elephant grass was assessed using the analysis of variance (ANOVA) and least significant difference (LSD) method at the 5% and 10% levels.

Results and Discussion

Changes in plant characteristics

Changes in plant height, tiller number, mean tiller weight, herbage mass, leaf area index (LAI) and ratio of leaf blade to stem with leaf sheath (LB/ST) both before and after grazing in DL elephant grass with a grazing cycle in 2003 are shown in Figure 1. Before grazing, plant height, mean tiller weight, herbage mass, LAI and LB/ST tended to be lower, whereas tiller number was higher for all paddocks from cycle 1 to cycle 3. Herbage mass and mean tiller weight tended to be higher, with a concurrent decrease in LB/ST for paddock 1-4 at the first cycle, and this was mainly due to the extension of the growing period before the start of grazing for paddocks 1-4, while tiller number in this cycle was relatively stable among paddocks. As the contrasting seasonal pattern, plant height, mean tiller weight, herbage mass and LAI tended to be higher for paddocks 1-4 at the third cycle, mainly due to the rapid decrease in air temperature after the second grazing. During rotational grazing, plant characters before grazing varied greatly among paddocks, while plant characters after grazing were more stable.

Changes in several plant characters in DL elephant grass both before and after grazing during the grazing cycle in 2004 are shown in Figure 2. Before grazing, plant height, LAI, LB/ST were highest, while tiller number tended to increase with a similar increasing tendency in herbage mass as the grazing progressed, except for the first grazing and paddock 4. Plant height, mean tiller weight and herbage mass tended to be lower in 2004 than in 2003, especially in the early grazing period because of the earlier grazing used in 2004 than in 2003.

Herbage consumption

Changes in herbage consumption (HC) and rate of herbage consumption (Rate of HC) in 2003 and 2004 are shown in Figure 3. In 2003, herbage consumption and rate of herbage consumption tended to decrease from cycle 1-3 in all paddocks, except for paddock 1, where they increased from cycle 1 and 2. In 2004, seasonal change in herbage consumption was different among paddocks, and herbage consumption tended to increase and decrease as grazing proceeded in paddocks 1 and 4 respectively. The rate of herbage consumption had similar seasonal change as herbage consumption, and generally tended to decrease with grazing, except at cycle 1 in paddock 1. Both herbage consumption and rate of herbage consumption were at the highest in the year grazing of 2004 than in 2003.

Changes in live weight of breeding and raising beef cows

The average daily (ADG) beef cows grazed in 2003 and 2004 is shown in Table 1. In 2003, ADG was highest at 0.45 kg/day during cycle 1, whereas ADG was negative during cycle 2 and 3. In 2004, ADG was positive during cycle 2 – 5, and the total seasonal ADG was higher in 2004 than in 2003. Therefore, the LW of the breeding beef cows was at least maintained under this rotational grazing system without any concentrate or supplied roughage in each year. Although the grazing period was reduced approximately 60% during the final cycle, compared to the previous cycles in both years, the carrying capacities during the first two

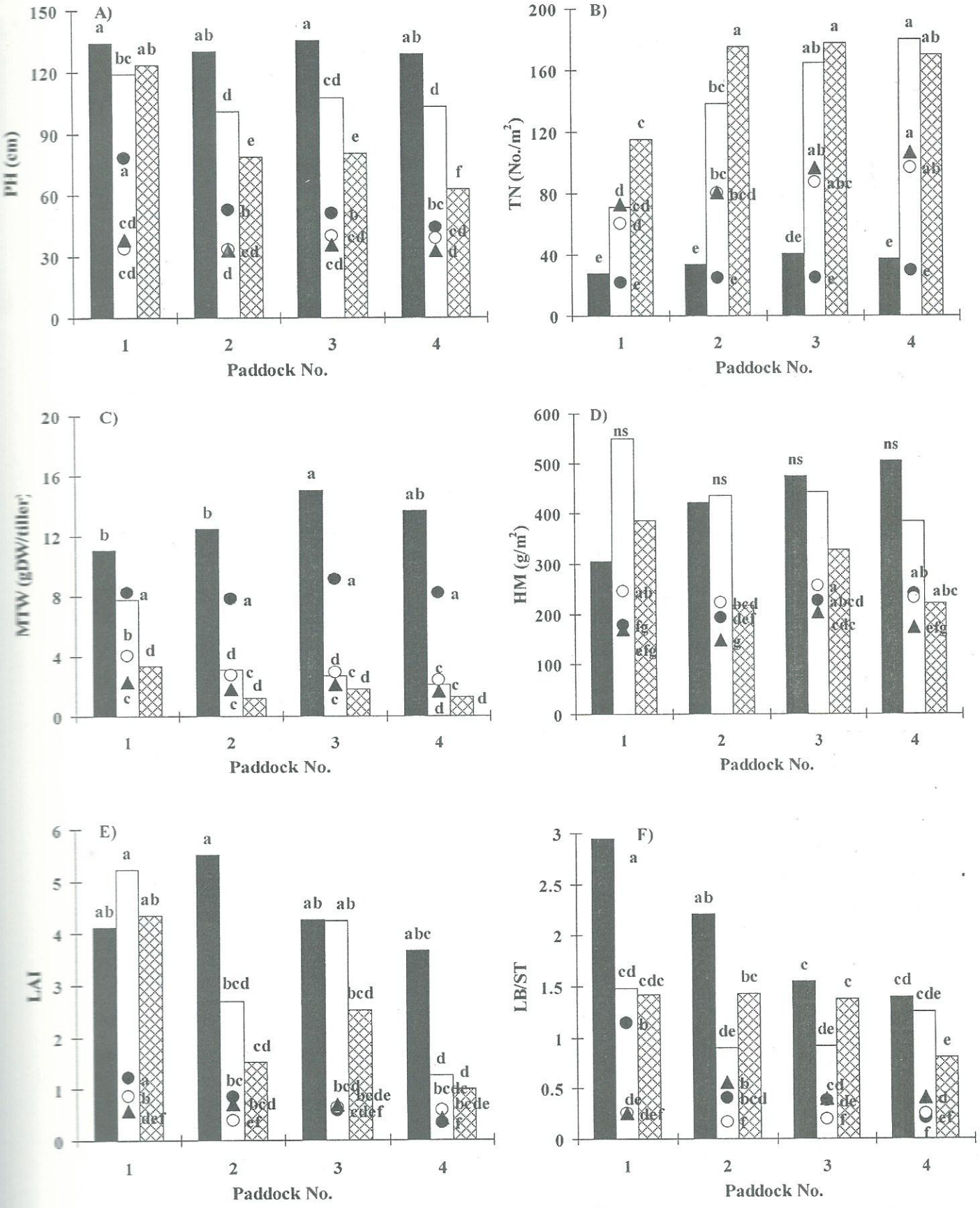

Figure 1. Change in (a) plant height (PH), (b) tiller number (TN), (c) mean tiller dry matter weight (MTW), (d) herbage mass (HM), (e) leaf area index (LAI) and (f) ratio of leaf blade to stem with leaf sheath (LB/ST) before and after grazing in 2003. Before grazing (bar chart): (■) first, (▨) second, (▨) third cycle. After grazing (dot chart): (●) first, (○) second, and (▲) third cycle. Different letters denote a significant difference at the 5% level.

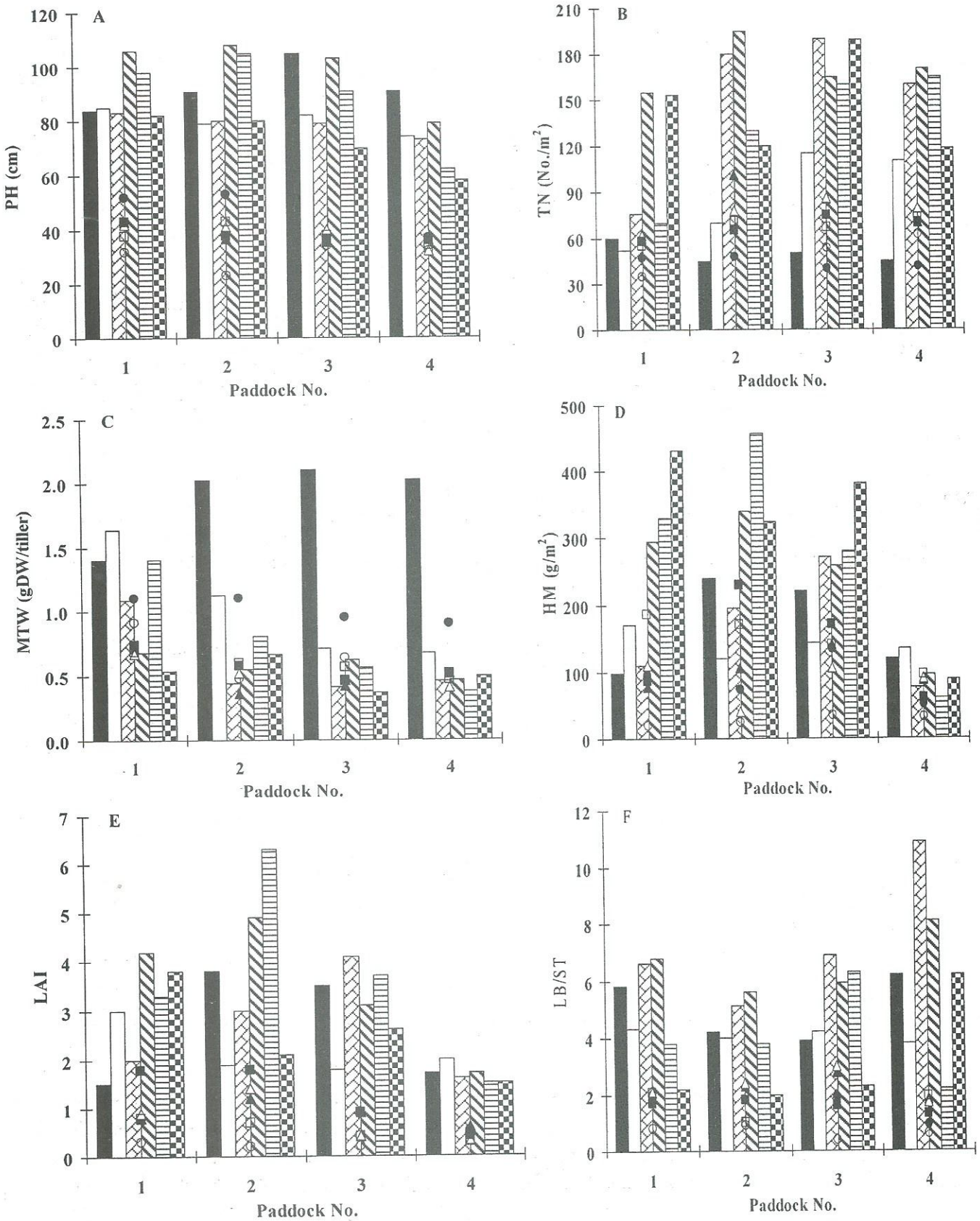

Figure 2. Change in (a) plant height (PH), (b) tiller number (TN), (c) mean tiller dry matter weight (MTW), (d) herbage mass (HM), (e) leaf area index (LAI) and (f) ratio of leaf blade to stem with leaf sheath (LB/ST) before and after grazing in 2004. Before grazing (bar chart) : (■) first, (□) second, (▨) third, (▧) fourth, (▤) Fifth and (▦) sixth cycle. After grazing (dot chart) : (●) first, (○) second, (▲) third, (Δ) fourth, (■) fifth, and (□) sixth cycle.

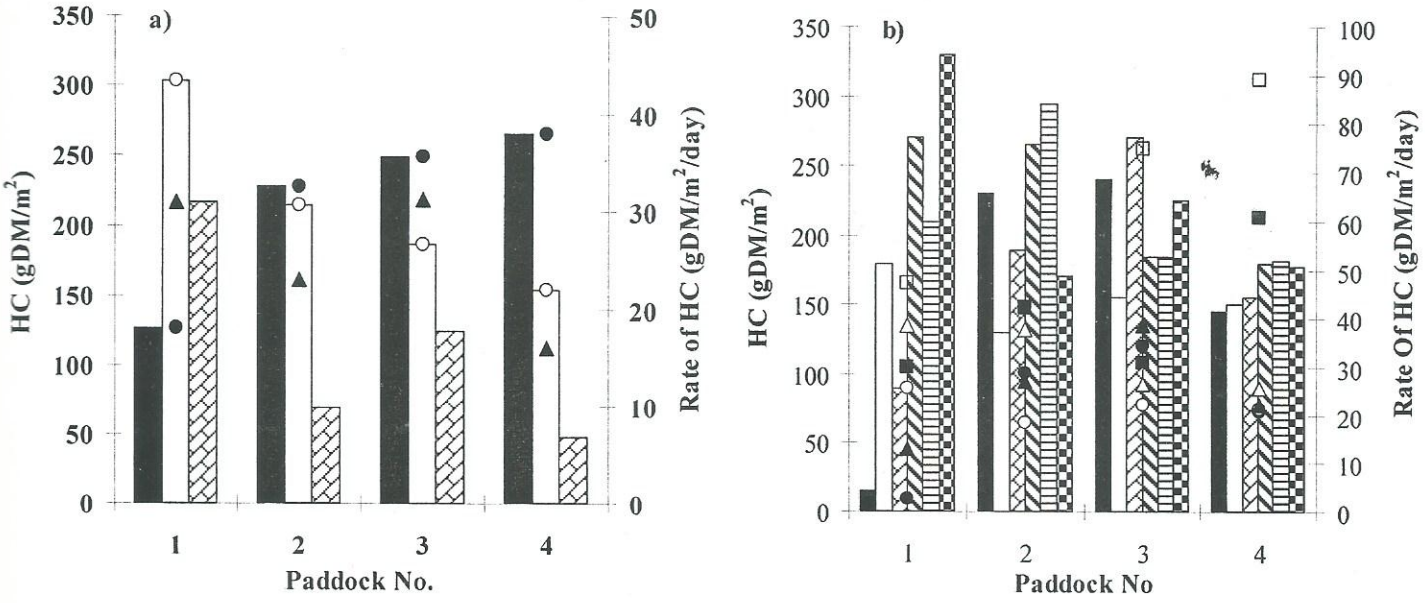

Figure 3. Change in herbage consumption and rate of herbage consumption in in 2003 (a) and 2004 (b). Herbage consumption (bar chart): (■) first, (□) second, (▨) third, (▧) fourth, (▤) fifth and (▦) sixth cycle. Rate of herbage consumption (dot chart): (●) first, (○) second, (▲) third, (Δ)fourth, (■) fifth, and (□) sixth cycle.

Table 1. Average daily gain (ADG) and carrying capacity of breeding beef cows in 2003 and 2004

Cycle	Period	Grazing length (days)				Stocking	Mean	ADG	Carriying
		1	2	3	4	(cattle/ha)	(kg/head)		(cow/day/ha)
2003									
1	28	7	7	7	7	15	455.9	0.54	383.0
2	28	7	7	7	7	15	457.7	-0.18	384.5
3	17	7	3	4	3	15	487.1	-0.22	248.4
2004									
1	28	6	8	7	7	15	355.0	-0.18	298.2
2	28	7	7	7	7	15	357.9	0.30	300.6
3	28	7	7	7	7	10	381.5	0.79	213.6
4	28	7	7	7	7	10	405.2	0.48	226.9
5	23	7	7	6	3	10	421.8	0.71	194.0
6	16	7	4	3	2	10	379	-0.013	121.5

cycles and the third cycle in 2003 were 768 CD per ha and 248 CD per ha respectively, and those during the first five cycles and the sixth cycle in 2004 were 1233 CD per ha and 122 CD per ha respectively.

Discussion

Herbage production and plant characteristics

Before grazing, herbage mass averaged 389.4 g/m^2 and 221.3 g/m^2 for the three and six grazing cycles in 2003 and 2004 respectively. The increased in herbage mass was correlated positively with that in plant height at the five level (r= 0.680 and 0.468 in 2003 and 2004, respectively) but it was not significantly correlated at the 5% level with the increase in tiller number in either year. The non-significant correlation of tiller number with herbage mass was derived from the significantly negative

correlation of tiller number with mean tiller weight at the 1% level (r= -0946 and -0.689 in 2003 and 2004, respectively) during grazing. However, the ratio of leaf blade to stem with leaf sheath decreased with the increase in herbage mass in 2004 (r= -0.437, P<0.05). The decrease in the ratio of leaf blade to stem with leaf sheath with the grazing cycle was associated with an increase in stem for DM accumulation.

The tendency for herbage mass to increase with grazing, especially in the second year suggested that DL elephant grass pasture expands the capacity to graze, and supplies enough herbage for beef cows for 1 week in every 4 weeks during the rainy season, with five cycles in the second year, in addition to 2–7 days of grazing during the last cycle. The number of tillers before grazing increased uniformly up to the third and fourth grazing in 2003 and 2004 respectively, and suggests a high tiller ability after defoliation of the mother tillers. An increase in tiller number with a concomitant decrease in mean tiller weight with the grazing cycle is a desirable tendency for plants to be consumed by grazing beef cows. It was because DL elephant grass had such a high mean tiller weight during the first grazing cycle that the consumption of a whole tiller tended not to be easy for grazing beef cows.

Plant height after grazing was confined to 30-50 cm in both years; except for paddock 1 at the first grazing in the first year and this height was mainly determined by the position of the leaf junction, because grazing beef cows are usually reluctant to graze stem parts. Relatively constant plant height after grazing may be caused by the high palatability of elephant grass for grazing cows.

Daily gain and carrying capacity for grazing beef cows (comparison of DL elephant grass with overseas tropical grass pastures)

Based on herbage consumption in the DL elephant grass pasture and the live weight of grazing beef cows, DM intake ranged from 10,2 to 14,5 and from 15.4 to 23.2 g DM kg $LW^{-1}day^{-1}$ among the four paddock in 2003 and 2004 respectively, except for the lowest DM intake in paddock 4 in 2004. The organic matter (OM) intake of grazing steers on banagrass (*Pennisetum purpureum* x *P. americanum*) over five grazing seasons was 8.37 kg/day (13.7 g OM kg/LW/day) in South Africa (Koster et al., 1992), which was equivalent to 14,7 g DM kg/LW/day), the same as the present study, if mineral content was 6%. The increase in DM intake during corresponding period in the second year relative to the first year was correlated with the increase in herbage allowance in the second year. Judging from breeding beef cow performance, 0.05 ha of DL elephant grass pasture can supply enough herbage (without concentrate) for a week to maintain the LW of three breeding beef cows and to keep ADG at 0.35 kg day^{-1} for two raising beef cows in the first and second years following establishment respectively. However, under a more lenient stocking rate at 1510 kg ha^{-1} day^{-1} on Mott dwarf elephant grass pasture in Florida, USA, compared to the high rate of 3786 LW/ha/day we used in 2004, ADG over 3 years was 0.97 kg for 15 to 18-month-old raising beef cows (Sollenberger and Jones, 1989). The inferior ADG in the present study is probably due mainly to the higher stocking rate with the shorter re-growth period in the present study for dwarf elephant grass, whereas a 35-day rest period was used in Florida, USA (Sollenberger and Jones, 1989).

The carrying capacities of DL elephant grass pasture was 1016 CD/ha in the first year and 1355 CD/ha in the second year. Because daily gain was negatively during the final cycle for both years, these carrying capacities were not underestimates. In the tropical grasses, ADG over time on three varieties of star grass swards in Florida, USA, ranged from 0.18 to 0.56 kg/day, and was inversely related to stocking rate when stocked with 7.5, 10 and 15 head/ha (average LW 230-250 kg; Adjei et al., 1980) and that on bahiagrass pasture was 0.38 kg/day for 15-to 18-month-old raising beef cows under the

lenient stocking rate of 1680 kg/LW/day in Florida, USA (Sollenberger and Jones, 1989).

Conclusions

A four-paddock system of DL elephant grass pasture with an area of 0.05 ha per paddock could be grazed rotationally by 3 head of breeding and raising beef cows in a rainy season period with a regime of 1 week grazing, then a 3 week rest period in the first and second years following establishment. The LW of beef cows were at least maintained for breeding cows and steadily increased for raising cows under this rotational system in a rainy season. Thus, the DL elephant grass pasture can be used under a rotational grazing system at 3.4–4.3 animal units/ha over the whole year in the low-altitude site of Miyazaki, Southern Kyushu. To increase the daily weight gains in grazing beef cows under rotational grazing system on DL pasture, it is necessary to reduce the stocking rate or to increase the rest period for restoring the regrowth of DL elephant grass.

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