

Grazing time and milk production of crossbred cows in a rotational area of Elephant grass and Tanzania grass*

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Abstract

This study was carried out in January of two consecutive years. The objective was to evaluate the grazing time, the grazing rate and the milk production of crossbred cows, managed in two rotational grazing areas, one with elephant grass (*Pennisetum purpureum* Schum. cv. Guaçu) and another one with Tanzania grass (*Panicum maximum* Jacq. cv. Tanzania), both with natural shade in the rest area. The experiment was divided in two phases, the first with 12 cows that remained day and night in the paddock and were milked twice a day. In the second phase 15 cows were observed and remained 10.43 hours in the paddock during the day, and were kept in a corral during the night. Each cow was observed every 15 minutes.

Grass specie had no effect on milk production in the two phases of the experiment. The grazing time was 564 and 474 minutes and the grazing rate was 28.7 and 24.4 minutes/hour for the Elephant grass and Tanzania grass, respectively, in first phase. In the second phase, the grazing time was 461 and 426 minutes and the grazing rate was 42.7 and 39.4 minutes/hour for the Elephant grass and Tanzania grass, respectively. Correlations were observed ($P < 0.01$) between grazing rate and the minimum temperature (-0.68), the maximum temperature (-0.76), the relative humidity (0.44) and the THI (-0.76).

Key Words: Behavior, bovine, environment, *Panicum maximum*, *Pennisetum purpureum*

Introduction

The efficient use of pasture systems requires the equilibrium of the different components that influence the production as well as the environment-animal-plant interactions and conditions. For grazing cattle the forage production, both the amount and the quality, the animal's characteristics, the environmental conditions and the concentrate management influence the behavior of the animals (Moore 1994). For the evaluation of the pastures, Forbes (1988) suggests that it should include the study of the environment and the forage consumption behavior of the ruminants, although this kind of study is very laborious and few published data present more than two consecutive days.

According to Forbes et al (1998), in the south of the United States, to have a good performance, the cattle need to be adapted to high temperatures, high relative humidity of the air and the ability to ingest low quality pastures. Heifers of the Angus, and Brahman breeds and their crosses, have been observed in pastures of *Cynodon dactylon*. The grazing time for the Angus heifers was shorter. From 11 am to 4 pm (the hottest period of the day) the Angus heifers did not graze while the grazing rate was 12 minutes/hour for crossbred animals and 20 minutes/ hour for the Brahman heifers. From 4 am to 6 pm, the grazing rate of the Angus heifers was 10 minutes/hour, while the crossbreds grazed 25 minutes/hour and the Brahman heifers 30 minutes/ hour.

The grazing time and the distance travelled during grazing influence significantly the efficiency of milk production (Fraser and Broom 1990; Van Soest 1994). The pasture quality is important too. Cows grazing good pastures spent 46% of the time grazing, while cows on bad quality pastures spent 62% of time grazing (Furlan 1976). Lucci et al (1969, 1972) studied the grazing time of dairy cows on pastures of Elephant grass cv. Napier and observed this was for 7 hours and 14 minutes and 8 hours and 16 minutes, respectively. Jersey cows had grazing rates of 15.8 minutes/hour, next to Sao Carlos and Ribeirao Preto cities, in the São Paulo State (Brazil). The day of observation and the period of the day influenced the grazing rates. In the rainy days, the grazing rate was 25 minutes/hour greater than in the hot days. In this study the daily average rumination time was from 428 to 609 minutes (Costa 1985). According to Van Soest (1994), the preference for cattle is to graze during the day. The longer periods are at sunrise and sunset. Dairy cows in a rotational grazing system preferred to graze from 7 pm to 11 pm, probably because of the high temperatures of the day, during the summer (Camargo 1996). Silva (1967) observed that, in general, the behavior of cows during 24 hours was 40.6% grazing, 33.4% ruminating and 26.0% in other activities.

The objective of the present study was to compare the milk production, the grazing time and the grazing rate of crossbred dairy cows, in two systems of rotational grazing.

Material and Methods

The research was carried out in an Experimental Station located in latitude South 21° 42' and longitude West 47 ° 24'. Cows were kept in a rotational grazing area of elephant grass (*Pennisetum purpureum* Schum. cv. Guaçu) and Tanzania grass (*Panicum maximum* Jacq. cv. Tanzania). The elephant grass area was 7.8 ha and was divided into 21 paddocks, with an occupation period of two days and a rest period of 40 days. For the Tanzania grazing system the area was 13.2 ha divided into 12 paddocks with an occupation period of three days and a rest period of 33 days. In each experimental area the cows had access to water, mineralized salt and trees to supply natural shade. Fertilizer application was 250 kg of N/ha per year subdivided in four applications, after each grazing period. The temperature and humidity index (THI) were calculated using the maximum temperature (t_{max}) of the air and temperature of the dew point (t_o) according to the following formula:

$$THI = t_{max} + 0.36 \cdot t_o + 41.2 \text{ (Baccari Jr 2001).}$$

The experiment was carried out in two distinct phases, in the first the cows had access to the pastures during the day and the night, except for the milking, and in the second the animals were

kept in the pastures only during the day.

The observation was carried out each 15 minutes (Gary et al 1970), 24 hours per day. The observers worked in turns of four hours during the day and three hours, during the night. The animals were recognized through numeration marked in the back and, during the night, with lanterns. Despite the fact that the observers walked inside the paddock to locate the cows, no influence on the behavior of the cows was noticed, probably because of the high frequency of observations.

In the first experimental phase, 12 crossbred cows (three genetic groups) were observed during 120 hours without interruption, at 15 minutes intervals, except when they were milked, twice a day. In the second experimental phase, to prevent robbery of the animals, it was necessary to keep the cows in the grazing area only during the day (6 am to 7 pm). Before sunset, the cows went to a paddock, without available food. Fifteen crossbred cows were observed during seven days, at 15 minutes intervals, except when during milking or in the paddock during the night.

Grazing and rumination time and milk production were observed. The variables used in this study were grazing time, rumination time, resting time, grazing rate and milk production. The grazing time was considered the time that the cows remained inside the paddocks grazing or searching for food. Rumination time was considered the time that the cows were ruminating in the paddocks or in the rest area. The rumination was not observed when the cows were milked. The rest time was considered as being the time when the cows were not grazing or ruminating, without the time expended milking. The grazing rate was calculated dividing the grazing time (minutes) for the time that the cows had remained in the pastures (hours).

The statistical analyses were made separately for 1st and 2nd experimental phases. To compare the variables a split plot design was used. The main treatments were the grass species, the genetic group (Holstein proportion) for the crossbred cows and the lactation phase. The day of observation was considered repetition in the time. The GLM procedure of the SAS software (SAS 1996) was used for the analysis. To study the effect of the day of occupation of the paddocks, the statistical analysis was made for each grass species separately, considering the day of occupation as the only source of variation. Correlations between the climatic variables and grazing time were calculated with the Proc Corr and Reg procedures of the SAS software (SAS1996).

Results and Discussion

After milking, the lactating cows went directly to the paddock to graze, both in the morning and in the afternoon. In the hottest part of the day, they remained in the shaded area. During the night cows remained all time inside the paddocks, grazing, ruminating or just resting. The number of lactating cows that were grazing is observed in the Figure 1 (average of 5 days of observation) during the day or the night.

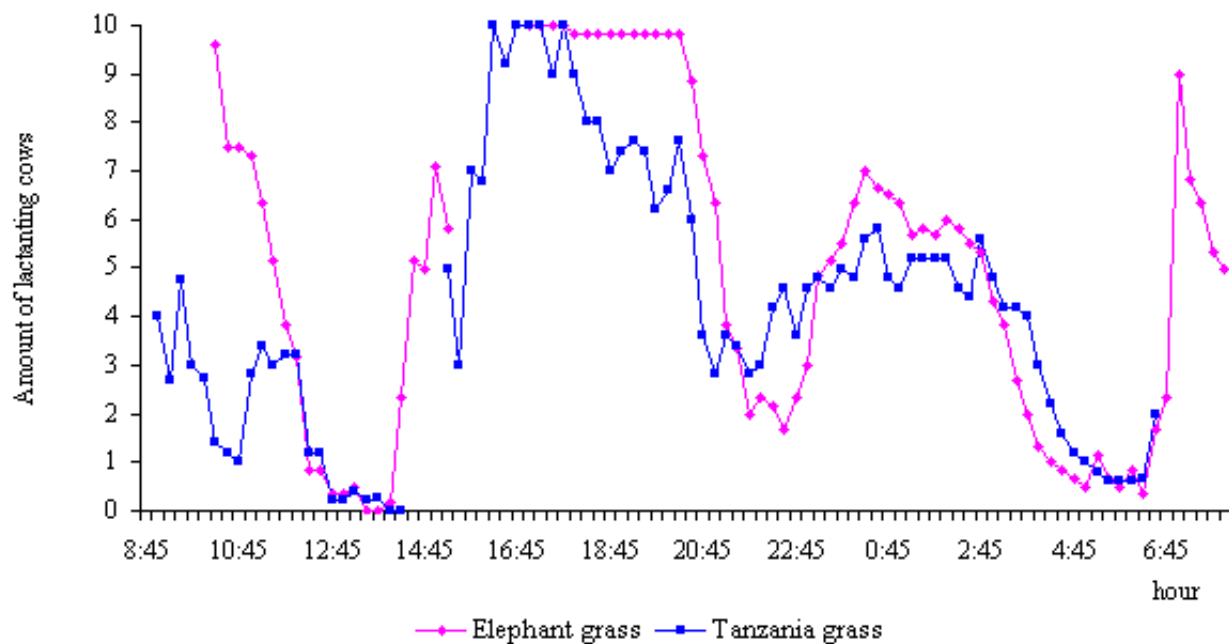


Figure 1. Number of cows in grazing activity according to the hour of the day, grazing Tanzania grass or Elephant grass

In Table 1 are the values for minimum and maximum environmental temperatures values, the precipitation (amount of rain), the relative humidity of air and the temperature and humidity index (THI).

Table 1. Minimum, maximum environmental temperature, precipitation, relative humidity (RH) and temperature and humidity index (THI), for each day in the 1st and 2nd experimental phases

Day	Temperature, ° C		Rain, mm	RH,%	THI
	Minimum	Maximum			
1 st phase					
1	21.0	34.5	0.0	65	83
2	21.1	32.6	0.0	68	81
3	20.4	33.3	0.0	72	81
4	20.5	32.0	3.0	84	80
5	21.0	32.8	50.8	76	80
2 nd phase					
1	20.0	32.0	0.0	66	80
2	21.0	33.4	0.0	67	82
3	20.9	31.4	0.0	74	79
4	20.0	26.9	39.4	91	75
5	18.9	25.0	26.4	86	73
6	18.0	26.3	7.0	82	74
7	17.5	29.0	1.0	70	76

There were difference between grass species for grazing time ($P<0.01$) and grazing rate ($P<0.01$) and between the days of observation. Also there was an interaction between grass species and day of observation ($P<0.01$) and between grass species and grazing rate ($P<0.01$). Therefore, the statistical analyses were made for the main effects separated (Table 2).

Table 2. Average of grazing time and grazing rate of lactating cows in elephant grass and Tanzania

grass, per day and average of milk production per cow, per day during the 1st experimental phase

Day	Grazing time, minutes		Grazing rate, minutes/hour		Milk production, kg/day
	Elephant grass	Tanzania grass	Elephant grass	Tanzania grass	
1	543 ^{aBC}	461 ^{bA}	28.4 ^{aAB}	24.3 ^{bA}	10.6 ^A
2	551 ^{aABC}	485 ^{bA}	27.9 ^{aAB}	23.6 ^{bA}	11.8 ^A
3	606 ^{aAB}	462 ^{bA}	31.9 ^{aA}	23.4 ^{bA}	10.5 ^A
4	470 ^{aC}	485 ^{aA}	24.4 ^{aB}	24.8 ^{aA}	10.8 ^A
5	645 ^{aA}	500 ^{bA}	31.5 ^{aA}	25.8 ^{bA}	11.0 ^A
Means	564 ^a	474 ^b	28.7 ^a	24.4 ^b	10.9

Means without common lower case letters, within a row, or common capital letters, within a column, are different by Tukey test ($P < 0.05$).

The time the cows spent grazing in the Elephant grass pasture was greater than recorded in the literature. Lucci et al (1969) and Lucci et al (1972) observed lactating cows during 72 hours and found grazing times of 7 hours and 14 minutes (434 minutes) and 8 hours and 16 minutes (496 minutes), respectively, working in paddocks with Elephant grass cv. Napier. In the same place and time of the present work, Rosseto (2000) studied the amount of leaves on the pastures (as a percentage of the DM) and calculated its disappearance in the pastures. The results were that 65% of the leaves of the Elephant grass and 92% of the leaves of the Tanzania grass disappeared during the occupation of the paddocks, which probably influenced the grazing time and the grazing rate.

The grazing rate for Tanzania grass was similar to that observed by Costa (1985), which was 25 minutes/hour for two rainy days, with low temperatures. In general, the average grazing rate for Tanzania grass and Elephant grass were greater than was observed for Jersey cows (15.8 minutes/hour) grazing a degraded pasture with supplementation of roughage and concentrate (Costa 1985).

There were no differences in milk production (Table 4) between grass species ($P > 0.31$), and no influence of the day ($P > 0.41$), genetic group ($P > 0.13$) or lactation phase of the cow ($P > 0.15$). The cows kept in the Elephant grass system produced daily an average of 11.1 kg of milk and the cows kept in Tanzania grass paddocks produced daily 10.8 kg of milk.

The rumination time was not influenced by the grass species ($P > 0.06$), but was influenced ($P < 0.01$) by the day of observation (Figure 2). No significant interaction between sources of variation was observed ($P > 0.90$). The average of rumination time was 342 minutes for the cows kept in the Elephant grass pasture and 300 minutes for the cows kept in Tanzania grass pastures; this corresponds to 29% and 34% of the total observation time, respectively. This result is similar to 33.4% for ruminating time described by Silva (1967). Costa (1985) observed, in the summer, greater rumination times, between 428 and 558 minutes, for Jersey cows kept in bad quality pastures and supplemented with roughage and concentrate. Probably the results found in the present study were lower because the rumination time during milking was not included. The resting time was not affected by the grass species ($P > 0.09$) but was affected by the observation day ($P < 0.01$). These results can be observed in Figure 2.

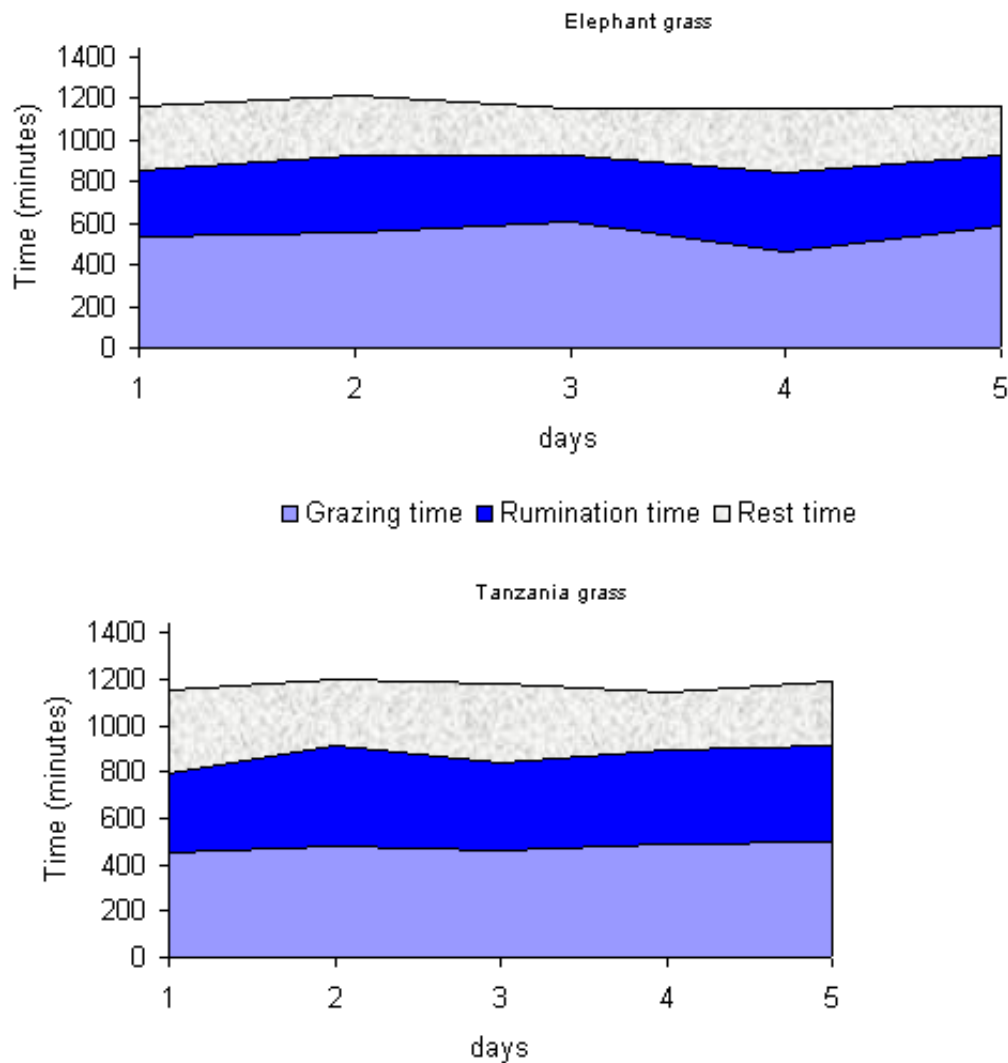


Figure 2. Time elapsed for grazing rumination and to rest in the 1st experimental phase for elephant and Tanzania grass systems

There was no effect of the genetic group of the cows or the lactation phase in the rumination and rest time. The average of rest time was 276 minutes per day, for the cows kept in elephant grass pastures, and 300 minutes per day for the cows kept in Tanzania grass, which represent 24% and 26% of the total of the observation time, respectively. These values are in accordance with Silva (1967) who estimated 26 % for rest time in relation to the total observation time. Lucci et al (1972) observed similar resting times (352 minutes per day), studying the behavior of lactating cows in Elephant grass cv. Napier.

The influence of occupation day of the paddock, for each grass species, was studied separately (Table 3).

Table 3. Averages of grazing time, rumination time, rest time, grazing rate and milk production for elephant grass and Tanzania grass during the 1st experimental phase, influenced by the occupation day of the paddock

Occupation day	Grazing time, minutes	Rumination time, minutes	Rest time, minutes	Grazing rate, minutes/hour	Milk/cow, kg/day
Elephant grass					
1 st	588 ^a	330 ^a	258 ^a	30.0 ^a	11.5 ^a
2 nd	510 ^b	366 ^b	294 ^a	26.4 ^b	10.5 ^a

	P<0.01	P<0.03	P>0.16	P<0.01	P>0.21
Tanzania grass					
1 st	492 ^a	384 ^a	300 ^a	24.6 ^a	10.1 ^a
2 nd	468 ^a	414 ^a	288 ^a	24.6 ^a	11.5 ^a
3 rd	462 ^a	378 ^a	342 ^a	23.4 ^a	10.7 ^a
	P<0.01	P>0.35	P>0.33	P>0.67	P>0.49

Means without common letters, within a column, are different by Tukey test (P<0.05)

For the lactating cows kept in the Elephant grass pasture the grazing and rumination time and grazing rate were significantly lower in the second day of occupation when compared to the first occupation day. There was no significant difference for rest time and milk production. In the Tanzania grass system, no significant differences were observed for the studied variables.

In the second experimental phase, the cows were kept in the pastures only during the day and in a pen, without food, during the night. The animals had access to pastures an average of 10.4 hour/day (626 minutes/day). The daily grazing time was lower for Tanzania grass than for the Elephant grass (P<0.01) (Table 4). There was an effect of the observation day (P<0.01) and a significant interaction between grass species and observation day (P<0.01). The disappearance of leaves after grazing was 59.7% for Elephant grass and 69.3% for Tanzania grass (Rosseto 2000), in accordance with the lower grazing time for cows kept in the Tanzania grass system (Table 4). The grazing rate, between 31 and 49.8 minutes/hour, was greater than that presented by Costa (1985), of 23.1 minutes/ hour, during the day period and 8.52 minutes/ hour during the night. There was no significant difference in milk production between grass species, but there was an influence of the day (P<0.01). Neither the genetic group nor the lactation phase affected milk yield. During the 5th, 6th and 7th day the cows grazed for a longer period (Table 4), because it rained and the temperature was lower.

Table 4. Average of grazing time, grazing rate of lactating cows in elephant grass and Tanzania grass, per day and average of milk production during the 2nd experimental phase

Day	Grazing time, minutes		Grazing rate, minutes/hour		Milk production, kg/day
	Elephant grass	Tanzania grass	Elephant grass	Tanzania grass	
1	395 ^{aD}	409 ^{aC}	33.1 ^{bC}	37.2 ^{aB}	10.9 ^A
2	456 ^{aBC}	326 ^{bD}	39.7 ^{aB}	31.0 ^{bC}	11.1 ^A
3	458 ^{aBC}	337 ^{bD}	41.6 ^{aB}	32.2 ^{bC}	11.1 ^A
4	430 ^{aCD}	443 ^{aBC}	41.1 ^{aB}	43.2 ^{aA}	9.8 ^B
5	522 ^{aA}	474 ^{bAB}	49.6 ^{aA}	43.8 ^{bA}	10.3 ^{AB}
6	486 ^{aAB}	476 ^{aAB}	49.8 ^{aA}	44.0 ^{bA}	10.8 ^A
7	482 ^{aAB}	513 ^{aA}	43.5 ^{aB}	44.0 ^{aA}	9.7 ^B
Means	461^a	426^b	42.7^a	39.4^b	10.5

Means without common lower case letters, within a row, or common capital letters, within a column, are different by Tukey test (P<0.05).

Only for the 2nd and 3rd observation days were there differences between genetic groups, when the 7/8 Holstein cows had the lowest grazing time. Those days were the hottest days of the experiment.

Forbes et al (1998) studied different breeds of bovines in hot environments and verified that the pure breed Angus had lower grazing time compared to crossbred animals (Angus * Brahman) and zebu (Brahman), showing the difficulty of adaptation of the European breeds to the tropical climate.

Table 5. Average of grazing time by lactating cows in Elephant grass and Tanzania grass pastures

Day	Genetic group (Holstein proportion)		
	1/2	3/4	7/8
1	408 ^{aBC}	398 ^{aB}	401 ^{aBC}
2	407 ^{aBC}	408 ^{aB}	358 ^{bC}
3	469 ^{aC}	434 ^{abAB}	388 ^{bBC}
4	418 ^{aABC}	443 ^{aAB}	456 ^{aAB}
5	502 ^{aA}	488 ^{aA}	503 ^{aA}
6	454 ^{aAB}	494 ^{aA}	491 ^{aA}
7	501 ^{aA}	501 ^{aA}	491 ^{aA}
Means	437 ^a	453 ^a	440 ^a

Means without common lower case letters, within a row, or common capital letters, within a column, are different by Tukey test ($P < 0.05$).

If the THI is 70 or lower it is considered to be normal, while from 71 to 78 is a critical level, and from 79 to 83 a danger situation. Above 83 can be considered a situation of emergency (Baccari Jr 2001). It was found that the lowest grazing time occurred when the THI was 82 (Table 1), indicating a stressful situation.

Similar to the 1st experimental phase, in the Elephant grass system the grazing time and grazing rate were significantly lower during the 2nd occupation day, but this did not result in differences for milk production. It was observed that the cows stopped grazing when the leaves were finished and waited for another pen to graze. The occupation day in the Tanzania grass system also affected the grazing time and the grazing rate, which were significantly lower on the 3rd day, but it had no effect in milk production. It was observed that cows spent more time looking for leaves in the 3rd occupation day because the proportion of leaves was lower. The results are different compared with the 1st experimental phase (no difference between occupations days) because the proportion of leaves in the pastures was higher in the first year.

In the 2nd experimental phase, when the cows had restricted access to the pastures, the grazing rate increased in the last three days when it rained and the temperature was lower than in the first day (Figures 3 and 4).

During the 1st experimental phase, when the cows were removed from the pastures only twice to be milked, the grazing rate was lower and without oscillations probably because of they had more grazing time available.

Correlation coefficients between grazing time and climatic variables, were calculated. No significant correlation between grazing time and the environment variables was observed. Macoon (1999) found reduction in the grazing time if the environmental temperature increased.

Table 6. Averages of grazing time, grazing rate and milk production for elephant grass and Tanzania grass during the 2nd experimental phase, influenced by the occupation day of de paddock

Occupation day	Grazing time, minutes	Grazing rate, minutes/hour	Milk/cow, kg/day
Elephant grass			

1 st	486 ^a	45.0 ^a	10.2 ^a
2 nd	444 ^b	40.8 ^b	10.5 ^a
	P<0.01	P<0.01	P>0.65
Tanzania grass			
1 st	402 ^b	37.8 ^b	11.1 ^a
2 nd	402 ^b	37.8 ^b	11.0 ^a
3 rd	456 ^a	41.4 ^a	10.1 ^a
	P<0.01	P>0.01	P>0.26

The statistical analyses were made for elephant grass and Tanzania grass separately. Means followed by different letters, within a column, are different by Tukey test ($P<0.05$).

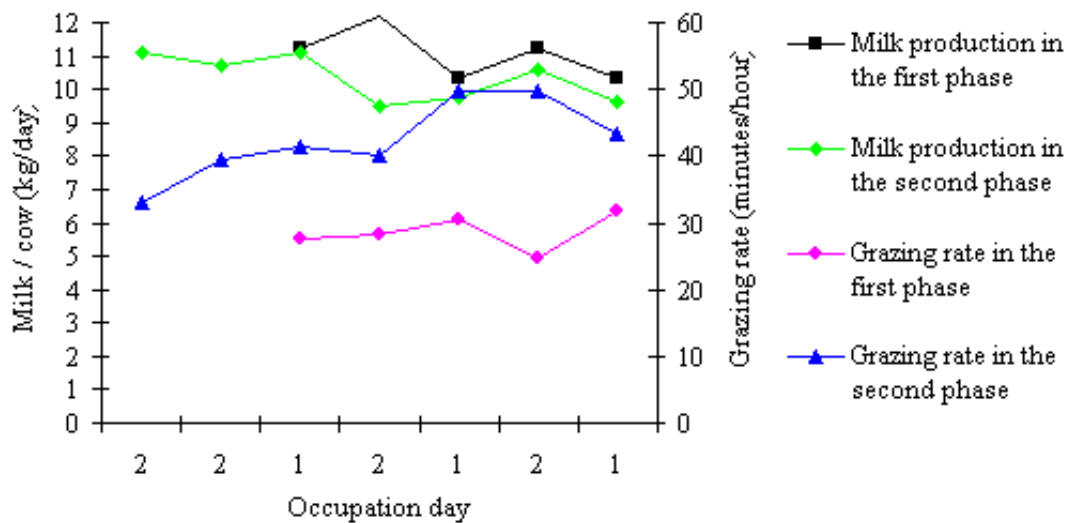


Figure 3. Averages milk production and grazing rate for cows kept in elephant grass pasture, influenced by the occupation day of the paddock, for the two experimental phases.

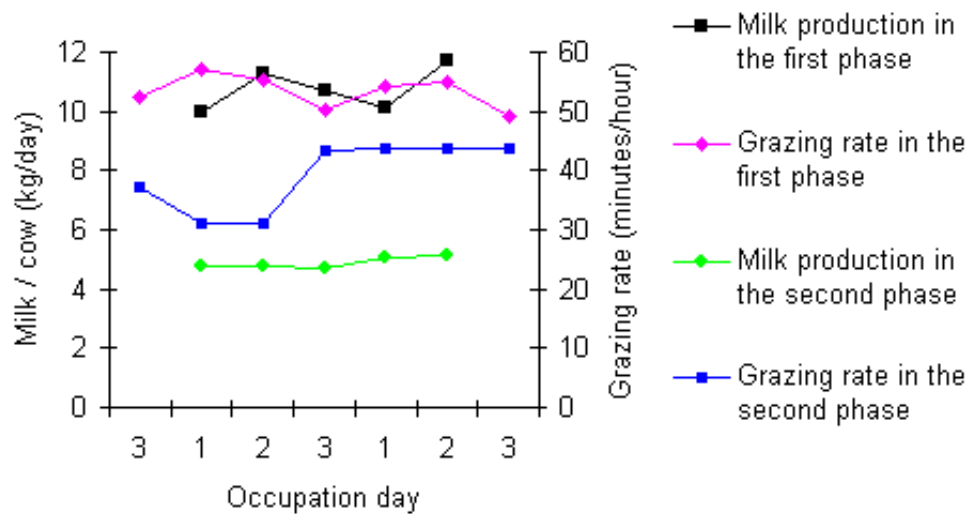


Figure 4. Average milk production and grazing rate for cows kept in Tanzania grass pasture influenced by the occupation day of the paddock, for the two experimental phases

There was a significant correlation ($P < 0.01$) between grazing rate and the minimum temperature (-0.68), maximum temperature (-0.76), relative humidity of air (0.44) and THI (-0.76). The relationship between minimum temperature (Figure 5) appeared to be curvilinear, indicating there was no further increase in grazing rate once the temperature fell to about 18 °C. At the other extreme (Figure 6) increase in maximum temperature led to linear decreases in grazing rate.

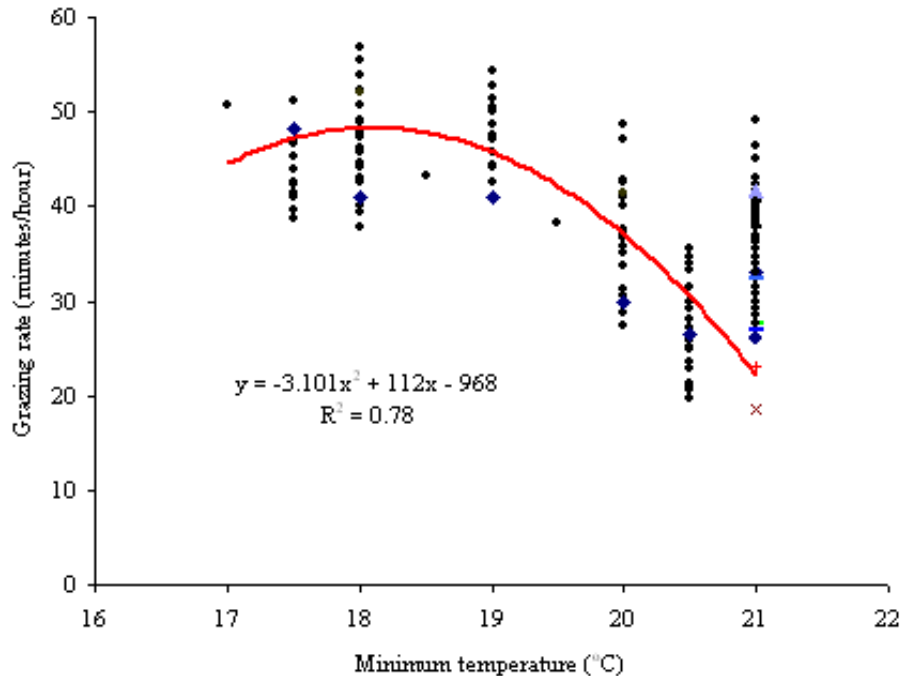


Figure 5. Effect of the minimum temperature (°C) on the grazing rate

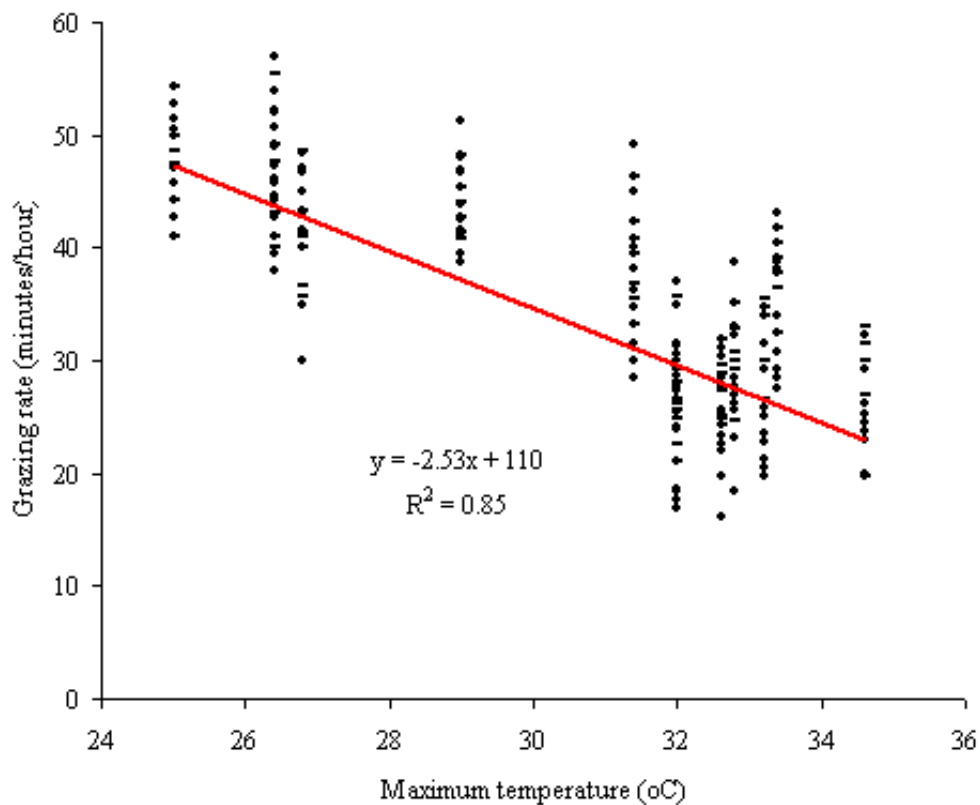


Figure 6. Effect of the maximum temperature ($^{\circ}\text{C}$) on grazing rate

The thermal index, as expected, was negatively and linearly related to grazing rate (Figure 7).

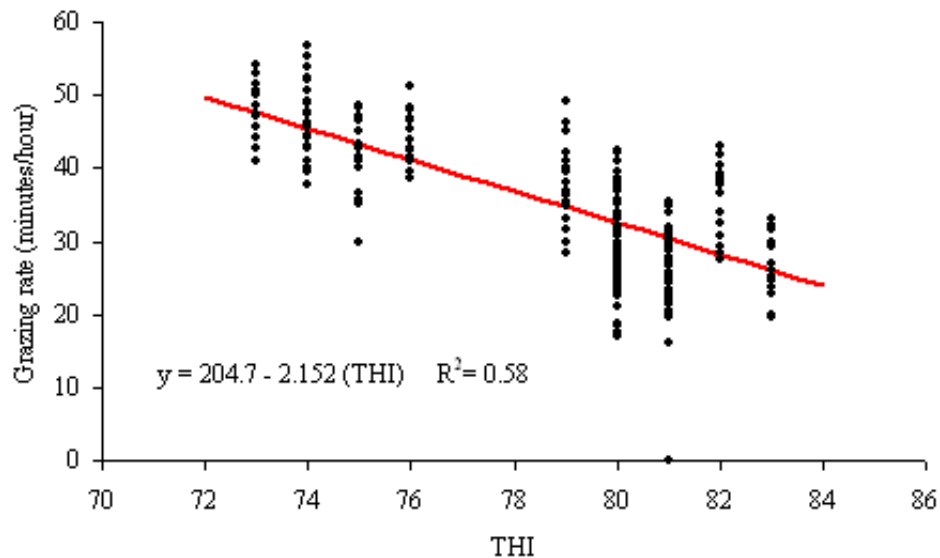


Figure 7. Effect of the THI on grazing rate

Conclusions

- Grass specie had no effect on milk production, however, grazing time was longer and the grazing rate on Elephant grass pasture was higher than on Tanzania grass pasture.
- For both grasses, grazing rate was negatively correlated with ambient temperature and the thermal index (THI).

Acknowledgements

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