Sveriges lantbruksuniversitet
Fakulteten för Veterinärmedicin och husdjursvetenskap
Institutionen för husdjurens miljö och hälsa

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Table of contents

1. ABSTRACT

The study was conducted in Shompole in southern Kenya. In this area people are pastoralists that rely on livestock as their only income, often both cattle, sheep and goats. They raise livestock under extensive conditions, using natural pasture as main food source for their animals. Six pastoral herds were included in this study that was carried out at 65 observation days from mid December 2009 to mid February 2010.

The objective of the study was to record foraging and locomotion behaviour of cattle, sheep and goats on natural pasture. Within these species, the focus was on diurnal behaviour to investigate if their behaviour was affected by the time since they left the settlement or rather by the actual time of day.

As expected in this dry area did goats mostly browse. Sheep and cattle performed almost no browsing at all which was a bit unexpected since the grass availability was low.

The natural feeding peaks for ruminants are around dusk and dawn. This was in my study changed by human management with night time penning and herding on daytime only. My results indicate that cattle behaviour during the day is very dependent on human influence. They walk the first and last hour and graze mostly in the middle of the day. This was not as clearly pronounced in sheep and goats.

All three species had a low resting frequency. This might be as a response to the limited grazing time but also because they are thermo tolerant and are not that affected by the heat. However, sheep had a small increase in resting during the hottest hours of the day, which was what we had expected in all species.

2. SAMMANFATTNING

Studien genomfördes i Shompole i södra Kenya. I det här området är invånarna herdar som förlitar sig på kor, får och getter som sin enda inkomstkälla. De föder upp boskap under extensiva förhållanden, med naturligt bete som huvudsaklig födokälla för sina djur. Sex besättningar av den typen ingick i studien som genomfördes från mitten av december 2009 till mitten av februari 2010, vilket gav totalt 65 observations-dagar.

Syftet med studien var att samla in födo- och förflyttningsbeteende hos nötkreatur, får och getter på bete. Inom dessa arter låg fokus på deras beteende under dagtid och att utreda om dessa beteenden påverkades av tiden sedan djuren lämnat bosättningen eller snarare av den faktiska tiden på dygnet.

Som förväntat i detta torra område åt getter mest från buskar och träd. Får och boskap åt nästan inte alls från buskar vilket var lite oväntat eftersom grästillgången var låg.

Det naturliga för idisslare är att äta mest runt skymning och gryning. Detta mönster var i min studie förändrat av mänsklig påverkan, med inhängning nattetid och av herdens påverkan under dagen. Mina resultat visar att nötkreaturs beteende under dagen var mycket beroende av mänsklig påverkan. De gick mycket den första och den sista timmen och betade mest mitt på dagen. Detta var inte lika uttalat hos får och getter.

Alla tre arterna hade en låg vilofrekvens. Detta kan vara ett svar på den begränsade betestiden men också tyda på att djuren är termotoleranta och inte påverkades av värmen i större utsträckning. Emellertid hade får en liten ökning av vilofrekvensen under de varmaste timmarna på dagen, vilket var vad jag hade förväntat mig hos alla arter.

3. INTRODUCTION

Pastoralists are people who rely on livestock as their main income; they cover about 70% of the total land area of Kenya. They often raise livestock under extensive conditions, using natural pastures as main feed source for their animals (Degen, 2007).

As pastoral societies in dry areas are dependent on seasonal rainfall can prolonged drought be disastrous for their livestock (Samuels et al., 2007). Since 2007 there has been poor or no rain during normal rain periods in many areas in Kenya; this extreme drought resulted in major losses for the pastoral people. People and animals starved to death and many pastoralists lost more than half their livestock (Western, 2009). The animals that are most affected are young calves and breeding females, which has large negative impact on herd recovery (Oba, 2001). In the end of 2009 and beginning of 2010 some rain improved the food situation but total recovery takes long time (www.wfp.org).

Zebu cattle (B*os indicus)* constitutes around 77% of the total cattle population in Kenya (Rege et al., 2001). Under extensive conditions, like in Shompole where our study took place, these indigenous breeds of livestock are even more common among farmers. These animals are under good conditions far less productive than exotic high producing breeds but they are well adapted to local conditions. Hence, they survive, reproduce and produce under harsh conditions where exotic breeds are not able to be kept (Rege et al., 2001). Western and Finch (1986) stated that Zebu cattle are less sensitive to food shortage and start gaining weight and increasing their milk production sooner after rain than cattle of European origin.

Pastoral people often own both cattle, sheep and goats, which they keep together at night. On daytime, sheep and goats are usually kept in the same herd but cattle graze apart from the small ruminants. Goats and sheep are often low producing but are even better adapted to drought than cattle which make them important in hard times. Goats and sheep are held both for milk and meat, whereas cattle are kept mostly for milk (Degen, 2007). Cattle have a big symbolic value and are rarely killed for meat (Western and Finch, 1986).

Goats are well adapted browsers (Animut and Goetsch, 2008). With their mobile upper lip, prehensile tongue and their ability to bipedal stance they can reach and select preferred plant species (Orihuela and Solano, 1999). Cattle and sheep are known to be grazers (Sanon et al., 2007). The dietary overlap is greater between these two species than between cattle or sheep compared to goats (Animut and Goetsch, 2008). However, in the dry season the lack of pasture leads to more browsing among both sheep and cattle (Ouédraogo-Koné et al., 2006; Sanon et al., 2007).

Circadian rhythms are processes that are automatic and vary regularly over the 24-hour cycle (Randall et al., 2002). Although circadian rhythms are decided within the animal, they are adjusted to the environment by external factors called “zeitgebers”, such as light, temperature and food availability. Light is the most

important zeitgeber and has large impact on the circadian rhythm (http://www.ne.se/lang/cirkadiansk-rytm). Melatonin is one of the leading hormones affecting the circadian activity of mammals, especially the balance between being awake and asleep. The production of melatonin is controlled by light; during night the production is high and during day its low (Randall et al., 2002). This pattern is seen in both night and day active animals, but the hormone affects them in different ways. There are a lot of other hormones controlling the animal and for example affecting the metabolism and hunger (http://www.ne.se/lang/cirkadiansk-rytm).

Many animals, including domestic ruminants, are crepuscular, meaning they are most active during dusk and dawn (Linnane et al., 2001). This pattern has from the beginning developed as an anti-predator strategy since predators are most active during night or in full daylight (Gregorini et al., 2006). However, there are several factors contributing to this behaviour (Linnane et al., 2001). When the sun starts to rise in the morning, crepuscular animals are stimulated by the light conditions and start grazing (Gregorini et al., 2006). This event is also induced by physiological requirements since grazing is normally low during night (Linnane et al., 2001). The ruminants then graze in periods through the day, decided by both animal factors such as rumen distension and intracellular pH and external factors such as weather conditions and social influence. When the sun start to set similar light conditions as at sunrise occur, which stimulates the animals to graze intensively (Gregorini et al., 2006). This grazing period is the most intense since other factors such as plant characteristics is favourable. For example increases the accumulation of photosynthates in the plants through the day both the dry matter and carbohydrate, which gives more digestible and better tasty plants in the evening compared to the morning (Linnane et al., 2001). This makes it beneficial to have the major grazing event at dusk. Linnane et al. (2001) also mention heat as another factor making it more advantageous to graze in dawn and dusk when it is cooler than around noon.

1. Aim of the study

The objective of this study was to compare foraging and locomotion behaviour in cattle, sheep and goats on pasture. Within these species I focused on diurnal behaviour and investigated if the animals' behaviour was affected rather by the time since they left the settlement or by the actual time of day. The results of this study could hopefully be used to improve herd management strategies.

4. MATERIALS AND METHODS

1. Study Area

The study was conducted in Shompole, Kajiado district in Rift Valley, southern Kenya. The region is characterized by high ambient temperature and low, bimodal rainfall (Morris et al., 2008) with short rains from October to December and long rains from March to May (Solomon et al., 1991). Mean annual rainfall varies from 300 to 800 mm. The habitat types in Kajiado include shrub grasslands, open grasslands, plains, open woodlands and swamps (Morris et al., 2008). Main grass species that dominate most areas in Rift Valley are Kikuyu grass, star grass, couch grass and wire grass (Lukuyu et al., 2009); the dominant tree species in Rift Valley are Acacia spp. (Agassiz and Harper, 2009).

The rangelands in Shompole are shared with wild animals and the conflict with wildlife is growing with diminishing resources according to the African Conservation Centre (ACC) (www.conservationafrica.org). With assistance of ACC, Shompole became a conservation area in 2002 (Morris et al., 2008). ACC is a Non-Governmental Organization dedicated to the development of African conservation. ACC works with local communities in areas with the best natural resources and wildlife and help these communities to understand the potential of these resources and teach them how to managing them sustainably. ACC often recruits pastoralist people from the area as research assistants; they know the surroundings and can speak to people to gain important information. In this way indigenous people can learn how to live side by side with wildlife with their livestock (www.conservationafrica.org).

Settlements (bomas) in Shompole consist of six to twelve dwellings surrounded by a protective enclosure. The bomas with people and livestock move between different areas in Shompole, decided by season, they move to places with the best pasture for their animals (Morris et al., 2008).

2. Animals and management system

During evening and night the animals are kept in the boma, i.e. a fenced place where both people and animals live. Cattle are kept within the circle of huts and sheep and goats within the inner enclosure. During daytime the animals are herded on natural pasture.

Goats and sheep compose the same herd on pasture and are guarded by the same herder. Cattle are kept in a separate herd with another herder. During the time of my study did the herders took the livestock out for grazing twice daily. They left early in the morning and were on pasture from 6 to 9, then they went back to the boma for milking and then they were out again around 11 to17. In the evening the animals were milked once more. If the pasture was poor close to the boma the herder took the animals further away and stayed out until evening.

The animals were given opportunity to drink in the river a few times a day but did

not have access to water all day at pasture.

The cattle were of indigenous breed, Small and Large East African Shorthorn Zebu (*Bos indicus)*. The cattle herds consisted of cows, heifers, bulls, steers and calves. The sheep were of indigenous fat-tailed breed and goats of an unknown indigenous breed. Both male and female goats and sheep of different ages were kept together.

3. Data collection

The data in the study were recorded by visual observation by two educated Masai. They are local people from the study area and had been trained by another Masai who had previously performed a similar study in Masai Mara.

The data were recorded during 65 observation days from the mid of December 2009 to mid February 2010: i.e. data collection started in the dry season and continued during the beginning of the rain season.

Six different herds were observed and behavioural data were recorded. The observer recorded data from different species on different days. The herd was selected by the observer who chose by the following criteria:

- Boma contains both cows, sheep and goats.
- Herds consist of at least twenty animals of every species.
- The bomas should not be situated too far away from the observer's home.

In the morning on each observation day the observer started a stopwatch just before the herd left the boma. Seven times per hour the recorder selected randomly twenty livestock from the herd and recorded their behaviour instantaneously as scan sampling. This was done on minutes 0:00, 0:05, 0:10, 0:20, 0:30, 0:40 and 0:50 of each hour. The recorded behaviours were standing, laying, grazing, browsing, foraging fruits and seeds, ruminating, social behaviour and moving; see the following definition.

Behaviour	Description
Standing	Animal standing without performing any other visible activity
Lying	Animal lying without performing any other visible activity.
Grazing	Animal standing or walking in grass with its head in a downward position.
Browsing	Animal standing or walking with its head in trees or shrubs.
Social behaviour	Two individuals of the same or different species interacting, for example mating, fighting, licking or nursing.
Ruminating	Animal chewing without any visible foodstuff in the mouth both lying, standing and moving.

Foraging fruits and seeds	Animal standing or walking under a tree with its head in a downward position. Fruit or seeds were seen on the ground by the observer.
Moving	Animal walking or running, without performing any other visible activity like social behaviour or foraging.

4. Data analysis

To make the results more transparent less frequent behaviours were added in bigger groups; standing, lying and ruminating were grouped into resting, foraging fruits and seeds were added to browsing and social behaviour to moving.

Hour from start was the time from when the animals left the settlement; hour 1 represented minute 0.00 to minute 0.59 etc. The actual time of the day was the hour of the day with for example hour 11 representing time from 10.30 to 11.29. Only hours with four or more recordings per hour were included in the analysis. In the hour from start analysis I merged hour 8 and 7 to hour 7 because there were too few observation-days these two hours to show them one by one.

The analysis was carried out in Minitab version 15, using the non-parametric Kruskal-Wallis test. My data was not normally distributed as tested with Anderson-Darling test, hence a parametric test could not be used.

All results are presented in per cent of observations as the mean ± standard-error of the mean.

5. RESULTS

1. Behavioural changes after leaving settlement

1. Cattle

Both grazing ($P < 0.001$) and moving ($P < 0.001$) were affected by hour from start (Fig. 1). Grazing was especially high during the first four hours from start when it constituted to almost 70% of recorded behaviours. Moving increased towards the end of the time on pasture. Browsing and resting were rare among cattle in this study.

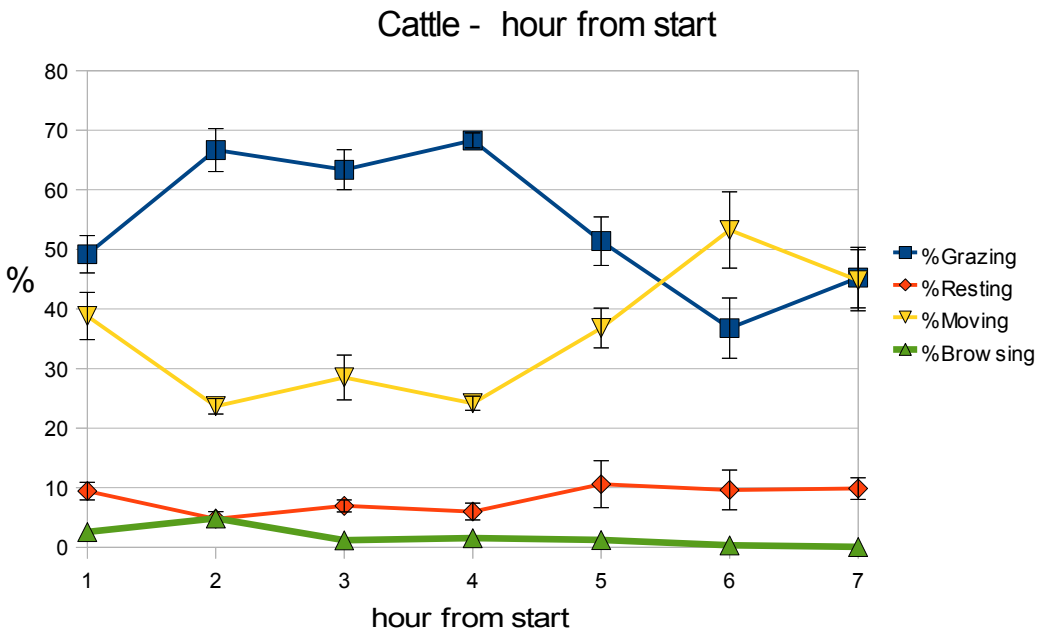

Figure 1. Percentage of observations of behaviour in six groups of Zebu cattle observed from when they left the boma (n=20 animals, observationdays 22, 22, 21, 20, 20, 14 and 12 for hours 1-7 respectively).

2. Sheep

In sheep hour from start affected both grazing ($P < 0.001$), moving ($P < 0.001$) and resting ($P < 0.001$, Fig 2). Moving was more frequent during the first and last hours but less frequent during hours 2-4. Grazing showed the opposite pattern to moving and resting and was less frequent the first and last hours. During hours 2-5 grazing was the dominating behaviour although there was a small decline hour three when resting increased. Browsing was a very rare activity among sheep.

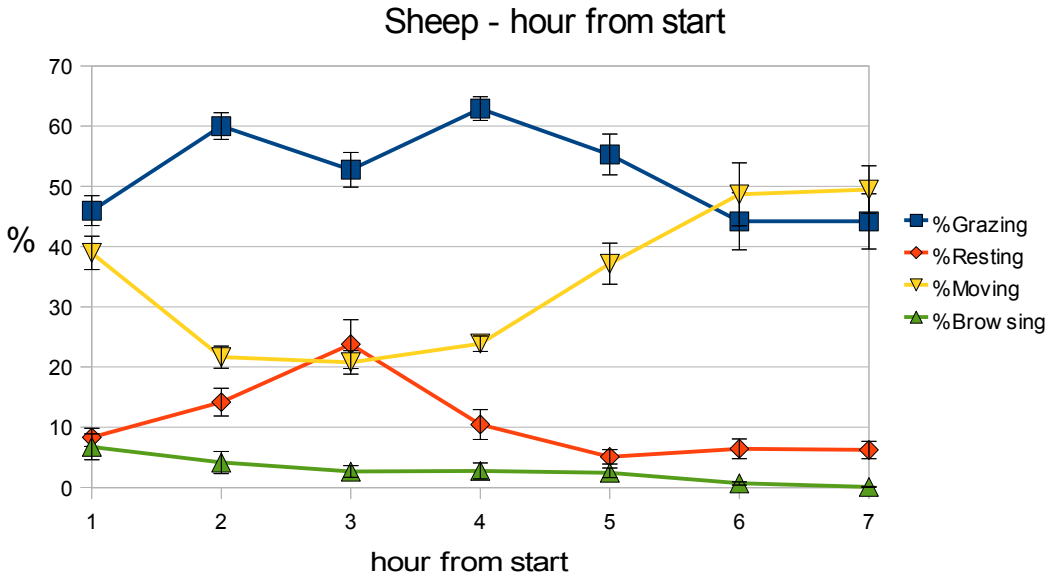

Figure 2. Percentage of observations of behaviour in six groups of sheep observed from when they left the boma (n=20 animals, observationdays 22, 22, 18, 15 , 15 , 12 , 8 for hours 1-7 respectively).

3. Goats

Only moving varied with hour from start ($P < 0.001$) and was most frequent during the first and last hour with a decrease at hours 2-4 (Fig. 3). Browsing was the dominating behaviour and constituted 40-50% of the recorded behaviours throughout the day.

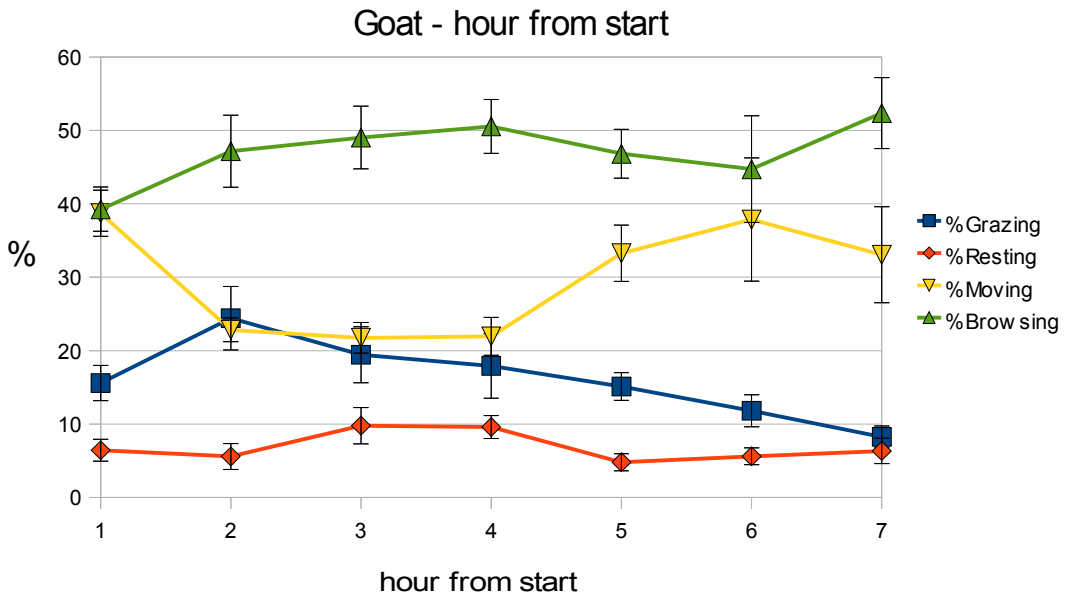

Figure 3. Percentage of observations of behaviour in six groups of goats observed from when they left the boma (n=20 animals, observationdays 21, 21, 17, 14, 14, 7 and 10 for hours 1-7 respectively).

2. Behaviour at different times of the day

1. Cattle

Grazing ($P < 0.001$) and moving ($P < 0.001$) were both affected by the actual time of the day (Fig 4). In the first and last hours cattle walked a lot but grazing frequency was low. In the middle of the day at 12-16 hours grazing was the dominating behaviour. Resting and browsing were relatively low and constant during the day.

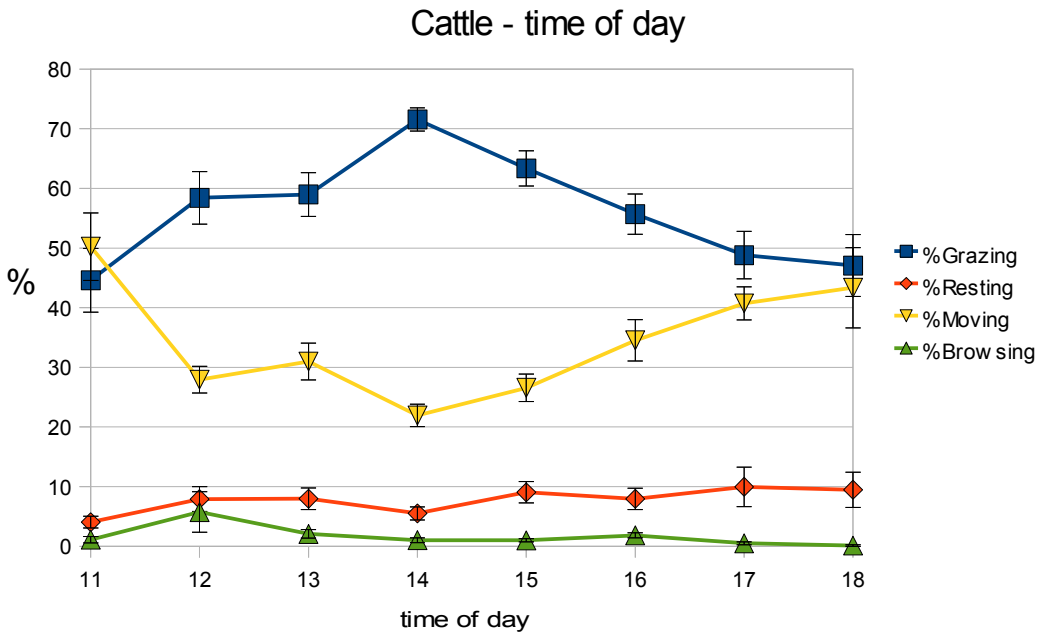

Figure 4. Percentage of observations of behaviour in six groups of Zebu cattle observed from when they left the boma (n=20 animals, observationdays 14 (hour 11), 19 (hour 12), 23 (hour 13), 21, 20, 21, 14 and, 7 for hours 14-18 respectively).

2. Sheep

The actual time of day affected moving ($P < 0.001$) and resting ($P < 0.01$) behaviour in sheep (Fig. 5). Grazing as the dominating behaviour did not vary by the time of day. Resting was increased at 14 and 15 hours whereas moving was decreased during these hours.

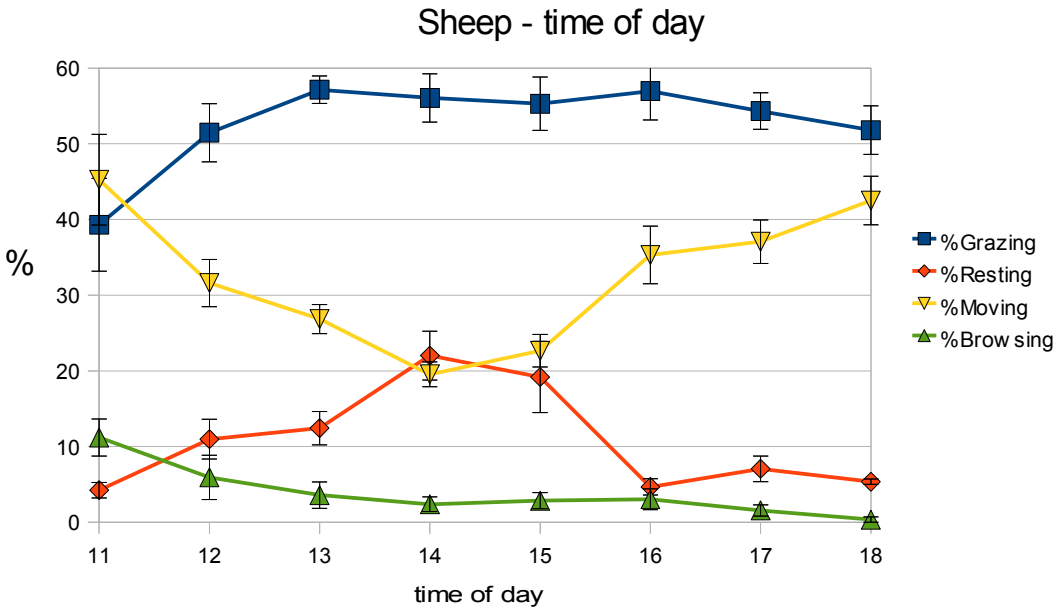

Figure 5. Percentage of observations of behaviour in six groups of sheep observed from when they left the boma (n=20 animals, observationdays 9, 18, 17, 16, 14, 14, 11, 2 for hours 14-18 respectively).

3. Goats

In goats were browsing (P<0,01), moving (P < 0.001) and resting (P <0,05) affected by the actual time of day (Fig. 6). Browsing increasing as the day went on. Resting was low but had a small increase at 14-15 hours. Moving was high at 11 hour, declining then and stabilised on a lower level. Grazing frequency was around 10-20% throughout the day and was not affected by time of day.

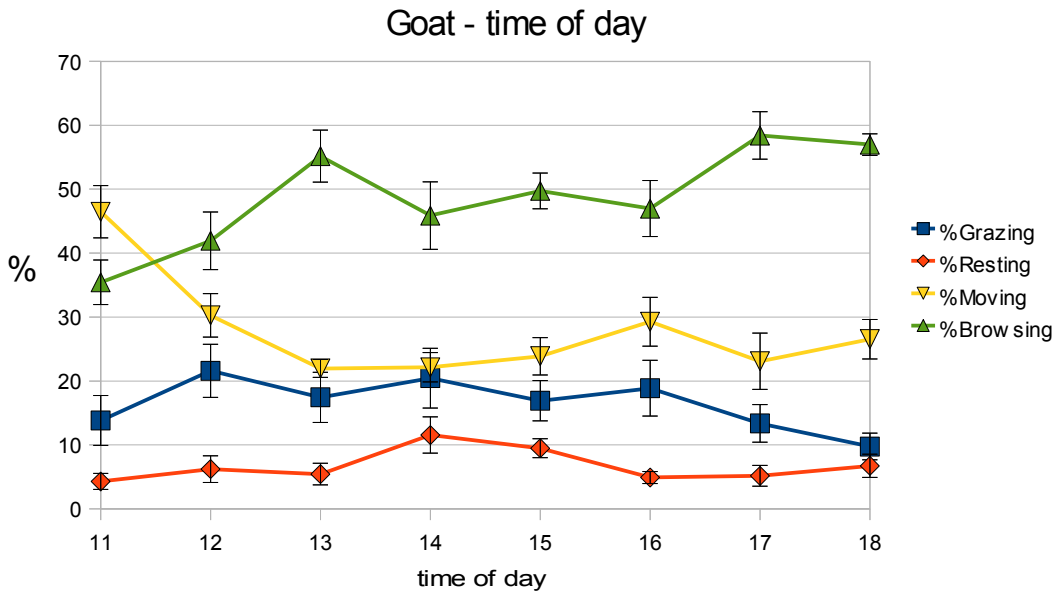

Figure 6. Percentage of observations of behaviour in six groups of goats observed from when they left the boma (n=20 animals, observationdays 9, 18, 17, 16, 14, 14, 11, 2 for hours 14-18 respectively).

6. DISCUSSION

1. Foraging behaviour

In my study did sheep and cattle hardly browse at all. This was a bit unexpected since Shompole was at least in the beginning of the study a very dry area with very little access to grass. Consistent with my results, Papachristou (1997) found in his study that sheep in dry conditions preferred grazing before browsing. However, this is not consistent with Kronberg and Malechek (1997) who showed an increase in browsing among sheep during the dry period. Sanon et al. (2007) also concluded that sheep browse more during dry season but that cattle did not spend any time on this activity. In contrast to cattle and sheep did the goats' in my study mainly browse. Ngwa et al. (2000) saw in their study that 75% of the goats diet came from tree and shrub species. Ouédraogo-Koné et al. (2006) concluded that the browsing time varies with season. They found in their behavioural study on cattle, sheep and goats that the difference between these species concerning feeding behaviour is bigger when forage availability is high. Hence, my results suggest that the animals experienced relatively good forage availability at the time of the study.

In sheep and goats the feeding frequency was quite evenly distributed throughout the day. This indicates that pasture availability was high, because if forage availability is low, animals move between places with better pasture and do not graze continuously. The reason that cattle did not show this pattern might be human influence. The herder might have made the animals walk until they reached a better pasture to stay for some hours and then walk home.

Linnane et al. (2001) performed a study in circadian grazing patterns of semi-wild cattle and concluded that cattle graze mostly in sunrise and sunset, with some small feeding periods during day and night. Shinde et al. (1997) did a similar study on sheep whereas Sharma et al. (1998) studied goats; both studies showed a resembling pattern with two major feeding periods divided by a resting period in the middle of the day. Butt (2010) concluded in his behavioural study on pastoralist managed cattle in Kenya that a bimodal grazing pattern was frequent during wet season but not during dry season. This was explained by the presence of pasture close to the settlements only during wet season. Butt (2010) also saw that during drought the herder walked longer distances with the herd to reach better pastures. Fierro and Bryant (1990) explained this changed grazing pattern in dry season with another herding strategy when the forage availability was low.

This natural feeding pattern around dusk and dawn was in my study changed by human management, as described by Bayer (1990) with for example penning during night and herding but also by environmental factors like high temperature and rains. The feeding activity and by that the forage intake can be reduced around noon because of discomfort caused by high temperature (Jung et al., 2002). Bayer (1990) concluded that when pasture is bad during the dry season the animals with limited time on pasture is less producing and lose more weight than free-ranging animals. Iason et al. (1999) concluded that sheep are able to

compensate for limited grazing time by changing their grazing behaviour but only if pasture quality is high. Sheep then graze longer periods and take larger bites to compensate for the shorter time on pasture.

Phillips and Hecheimi (1989) saw in their study on dairy cows that rumen conditions were stabilised by spreading periods of food intake evenly over the day and night. However, ruminants are able to eat large amounts of forage fast and ruminate it later unlike monogastric herbivores that have to eat continuous throughout the day (Piccione et al., 2007). How much ruminants are able to eat at once is limited by the size of their reticulo-rumen (Allison, 1985).

During dry season with very hot days, animals on 24-hours pasture often choose to increase their eating during night and rest more during the day (Sharma et al., 1998). Animals in pastoral societies are often fenced during night and thereby only have access to pasture during day and have to graze during the hottest part of the day to be able to cover their nutritional demands (Bayer, 1990). The cattle in my study showed no signs of increased resting during the hottest hours in the middle of the day. Consistent with my results, Bayer (1990) found in his study on indigenous cattle with limited grazing time that they continued to graze all day despite high temperatures. This as a response to the restricted grazing time due to night time penning (Bayer, 1990). The animals intensify their grazing during the day and delay resting and ruminating until they reach the Boma in the evening (Iason et al., 1999). Another explanation by Bayer (1990) is that indigenous cattle are more thermo tolerant and are not disturbed by the heat. This theory is supported by Hansen (2004) who explained in several ways that the Zebu cattle are well adapted to the heat. This ability has developed over long time and is a result of both reduced production of heat and increased capacity for heat loss to the environment. A major contributing factor to thermo-tolerance of zebu is the low growth rates and milk yield which lead to less heat production.

2. Resting behaviour

In the third hour after leaving the boma we can see that sheep had a period of increased resting with a decrease in grazing. This peak in resting around hours 14-15 actual time of day is followed by a decrease in moving instead of a decrease in grazing. A decrease in moving during these hours was also found in cattle. In goats there was a small but significant increase in resting the same hours as sheep. Because of the hot climate we had expected an increased resting in all species.

In Sharma et al. (1998) goats that had the choice avoided to graze/browse during the hottest part of the day. Ouédraogo-Koné et al. (2006) suggest that the reason why cattle do not rest might be due to the herders, who prevent the animals from resting until they reached the Boma at night. The reason why we see a clearer pattern in sheep might be that sheep are less thermo-tolerant than goats and cattle. Silanikove (2000) found in his study that goats are more adapted to hotter environment than sheep. Another explanation can be that the sheep were satisfied and lie down ruminating. However, Animut et al. (2005) concluded that goats rest more than sheep. Cattle were not in the same herd as sheep and goats which mean that they might be on better pasture because they walk longer distances. Cattle are

larger than sheep and goats and require larger quantities of food why they might have to graze all time offered.

One explanation to the low resting frequency in all species based on the results of Fierro and Bryant (1990) and Sanon et al. (2007) is that forage availability was relatively high. They found in their behavioural studies that time spent resting was negatively correlated with forage availability. However, to explain my results this theory requires that forage availability is higher for goats and cattle than for sheep. On the opposite of this Linnane et al. (2001) concluded that animals continued to feed until their nutritional demands are satisfied, which would result in longer feeding time in dry season. Animals with limited time on pasture are expected to compensate for this by eating larger part of the day (Iason et al., 1999).

3. Moving behaviour

Walking constituted nearly all recorded behaviours of moving recordings while social behaviour was very rare (Jonsson, 2011). This means I can assume that a high frequency moving mean that the animals walking a lot.

Butt (2010) concluded that walking is inversely related to grazing, which was also the case in my study. When the herders make the animals walk in the morning and evening they did not have the time to eat, and when they had reached the pasture they did not walk that much.

Time of the day affect how much the animals move. In the middle of the day the animals moved less than in the beginning and in the end this might depend on either the high temperature at noon or that they are on pasture and the animals move less because they eat.

4. Advice

The observers did not join the herd at the short walk before milking in the morning, thus we cannot know what the animals did those hours although this can affect the way the animals behave during the rest of the day.

To be able to give good advice to the farmers the milk production, body weight and body condition score of the animals should be included in the study. Results of such a study would give more answers and help the farmers to maximise their production with their resources.

The difference between the species can be an advantage since co-grazing enables a higher stocking rate than if species graze one by one (Animut and Goetsch, 2008). The dietary overlap between species is the determining factor how profitable this can be for the owner. The more unlike the species are the better the conditions are for success. One advantage is that goats feed on bushes and make space for grass to grow better, which give sheep and cattle more food. Another advantage is that goats and sheep are more tolerant and can eat plants that are poisonous for cattle (Animut and Goetsch, 2008). In the observed herds co-grazing of sheep and goats were used. Considering the results in my study this

seems like a good decision because goats and sheep forage very different.

Sufficient water intake is essential for milk production. If the animals drink more they eat more and by that produce more milk which is the reason why they are held (www.delaval.se). If every animal produce more milk, the farmer can sell the remaining milk and get a better economic situation. That is a good reason for putting some extra effort in finding enough and good quality water for the animals. When exposed to heat animals lose water by sweating (Hansen, 2004). To conserve water animals stay in shadow during the hottest part of the day. Shinde et al (1997) suggested that grazing hours, for animals with limited grazing time, could be increased during dry season since the animals have to feed longer time to ingest the same amount of food but also because the animals then could choose to avoid the sun around noon.

7. CONCLUSIONS

My study confirms that goats prefer browsing before grazing. However, sheep and cattle browsed less than expected in such a dry area as Shompole. This probably was because of a very low availability of browsing species used by these animals.

All species had a low resting frequency. Only sheep had a small increase in resting during the hottest hours of the day, which was what we had expected in all species. This might be as a response to the limited grazing time but also because they are thermo tolerant and are not that affected by the heat.

In this study cattle behaviour was very dependent on human influence. They walked the first and last hour and grazed mostly in the middle of the day.

8. ACKNOWLEDGEMENTS

The first person I like to give my thanks to is my supervisor Dr. Jens Jung, who is the one making this study and our trip to Kenya possible. Next person I like to give thanks to is Helena, who made another part of this study and who is the reason I decided to go to Kenya in the first place. Without her support and our discussions this would have been a much tougher assignment. I also want to direct a special thanks to Daniel and Francis for their careful and patient work with recording the data, and to Samantha Russels and Andrew Muchiru for their help in Kenya coordinating the study. Finally, I am very grateful for the help and support from my family.

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