Grazing behavior of Ankole and Boran cattle in an improved herding production system

Betesbeteende hos Ankole och Boran boskap i ett förbättrat betessystem

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Uppsala 2014

Husdjursvetenskap

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Student report ***No. 593***
Swedish University of Agricultural Sciences
Department of Animal Environment and Health

ISSN 1652-280X

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Examensarbete för kandidatexamen, Nivå: Grund G2E, 15 hp, Kandidatprogrammet – husdjur, kurskod EX0568

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Nyckelord: Grazing behavior, tropical conditions, Ankole, Boran cattle, human-animal interactions, herded cattle

Serie: Studentarbete/Sveriges lantbruksuniversitet, Institutionen för husdjurens miljö och hälsa, nr. 593, ISSN 1652-280X

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Abstract

To be able to provide the growing human population with food, the productivity of the animals as well as land use needs to be improved and intensified. Hence, understanding the behavior of animals is crucial both for animal welfare and productivity as well as the management of the cattle. There are many factors affecting the grazing behavior of cattle in tropical conditions, such as human-animal interactions, herd management, breed, season and temperature. The purpose of this study was to investigate the grazing behavior of two tropical cattle breeds, Ankole and Boran cattle. Kenyan Boran belongs to a zebu type of cattle and is preferred to many other breeds due to the higher productive and reproductive capacity and adaptability to tropical conditions. Ankole cattle are a stabilized crossbred of *Bos indicus* (Zebu) and *Bos taurus* cattle characterized by large horns and a large umbilical flap. It is an indigenous breed of the central and eastern parts of Africa, and is well adapted to harsh climate and environments with diseases and parasites. The study was carried out at Ol Pejeta Conservancy in Kenya. Different behaviors were recorded in intervals of 10 minutes on 18 adult non-lactating cows of each breed during the first five hours of the pasture time. Ankole cattle spent more time resting (4.9 %) than Boran cattle (1.95 %) ($p=0.001$). Ankole cows also spent more time in shade than Boran cows ($p=0.03$). The distance to the nearest cow was higher in Ankole cattle than in Boran cattle ($p<0.001$) as was the distance to herder ($p=0.003$). Both breeds spent most of their pasture time grazing; Ankole 63.23% and Boran 66.07 % followed by walking with 30.1% in both breeds. Grazing was most common during the second and fifth hour, and walking during the first, third and fourth hour, probably due to the herding management. These findings indicate that the large horns of Ankole cattle restrict their grazing to some extent. Also, it might influence the herd structure by increasing the distance between the cows, which was larger in Ankole. Boran cattle seemed to use the available pasture time more efficient on grazing, and hardly any time on resting. This study is to be considered as a pilot study and further investigation and research needs to be done on this subject.

Sammanfattning

För att kunna förse den ökande världsbefolkningen med mat måste produktivitet hos djuren och lantbruket förbättras och intensifieras. Förståelse för djurens beteende är avgörande för både deras välfärd och produktivitet samt för att kunna hantera dem. Det finns flera olika faktorer som påverkar betesbeteende hos boskap i tropiska förhållanden såsom interaktioner mellan djur och människa, djurens ras, säsong och klimat. Syfte med denna studie var att undersöka betesbeteende på två olika tropiska boskapsraser, Ankole- och Boranboskap. Kenyansk Boran tillhör zebuboskap och föredras framför andra raser på grund av deras högre produktivitet och reproduktionsförmåga samt anpassning till tropiska förhållanden. Ankoleboskap är en stabiliserad korsning mellan *Bos indicus* (Zebu) och *Bos taurus*, och karaktäriseras av dess stora horn. Det är en inhemsk ras i östra och centrala Afrika, och är väl anpassad till det krävande klimatet och miljöer med tropiska sjukdomar och parasiter. Studien utfördes på Ol Pejeta Conservancy i Kenya. Olika beteenden registrerades i 10 minuters intervall på 18 vuxna icke-lakterande kor av båda raser under de första fem timmarna på betet. Ankolekor använde mer tid för att vila (4,9 %) jämfört med Borankor (1,95%) ($p=0,001$). Ankolekor spenderade även mer tid i skugga än Borankorna ($p<0,001$). Avståndet till närmaste ko var större hos Ankole jämfört med Boran ($p<0,001$); så var även avståndet till herden ($p=0,003$). Båda raserna spenderade största delen av tiden på betet med att beta (Ankole 63.23 %, Boran 66.07 %). Bägge raser gick med 30,1 % av tiden lika mycket. Betandet var vanligast vid andra och femte timmen på betet medan gåendet var vanligast vid första, tredje och fjärde timmen, förmodligen på grund av herdarnas påverkan. Dessa resultat antyder att de stora hornen av Ankolekor begränsar deras betande i viss mån. Det kan även påverka flockstrukturen genom att öka avståndet mellan korna, som var högre hos Ankole. Boran verkar använda den tillgängliga betestiden mer effektivt på betandet och nästan ingen tid på att vila. Denna studie ska anses som en pilotstudie, och ytterligare forskning behövs inom detta ämne.

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Introduction

Background

As a result of the fast human population growth over the last decades, urbanization and income have increased rapidly especially in developing countries. This puts a high pressure on meat and other animal producers to meet the growing demand on products of animal origin (FAO, 2009; Delgado *et al.*, 1999; Bouwman *et al.*, 2005). To be able to increase the production, both number of animals and productivity per animal need to be increased, of which higher productivity is of greater importance than the number of animals (Alexandratos and Bruisnma, 2012). To be able to increase the productivity, animal nutrition, breeding and management need to be improved. The growing numbers of both humans and domestic animals increase the pressure of using the best land for crop production instead of using them for grazing. This in turn decreases the land area that can be used for pasture and thereby causes problems with overgrazing (Phillips, 2010). In order to increase the productivity and intensify both the production and land use, it is important to investigate the grazing behavior of cattle and different factors influencing it.

Ankole and Boran cattle

The humped cattle originating from India (*Bos indicus* or zebu cattle) have a very high tolerance for heat compared to humpless *Bos taurus* breeds in Europe (Hansen, 2004; Blackshaw and Blackshaw, 1994; Phillips, 2010). This thermo-tolerance is due to reduced heat production and increased loss of heat to the environment of the *Bos indicus* breeds. These animals have many physiological, morphological and cellular characteristics that enable a unique and useful adaptation to tropical conditions (Hansen, 2004; Phillips, 2010; Blackshaw and Blackshaw, 1994; Carvalho *et al.*, 1995). The cost of the increased adaptation to tropical conditions is the low productivity of these breeds, when comparing to European breeds, due to the increased heat production (Kosgey *et al.*, 2008; Hansen, 2004; Phillips, 2010). Zebu cattle are used as multi-purpose animals, mainly for milk, meat and draft power and as a source of income and manure. The importance of the functions varies between the different areas (Rege, 2001).

Kenyan Boran breed, which belongs to the zebu type, evolved from populations of Ethiopian Boran cattle and have undergone genetic improvement for beef production but are also used for milk production by pastoral communities (DAGRIS, 2014). The breed comprises the largest proportion of *Bos indicus* breeds kept primarily for beef production in the arid and semi-arid areas of Kenya (Wasike *et al.*, 2008). Kenyan Boran cattle are preferred to many other breeds due to the higher productive and reproductive capacity and adaptability to tropical conditions (Wasike *et al.*, 2008) that is a long life due to its high fertility, drought resistance, high degree of disease resistance and tolerance, good heat tolerance and protection against solar radiation as well as high adaptability to a variety of climates (DAGRIS, 2014).

The humpless cattle of West and Central Africa belong to taurine group of cattle (*Bos taurus)* and are indigenous breeds of Africa. They are well adapted to humid and warm climatic conditions and have developed a resistance to various diseases of these areas (Rege, 1999). This adaptation has contributed to their small size and low productivity when comparing to European taurines, or to zebu breeds kept in more arid areas in tropics

(Aboagye *et al.*, 1994). These breeds are also known for their high fertility, low inter calf periods, ease of calving and cow efficiency (Strydom, 2000).

Ankole cattle, also known as Watusi (Grimaud *et al.* 2007), are a stabilized crossbred of *Bos indicus* (Zebu) and *Bos taurus* cattle and thereby belongs to the Sanga group of cattle (Wurzinger *et. al.*, 2006; Petersen *et al.* 2004) characterized by large horns and a large umbilical flap, typically found in zebuine breeds (Huber *et al*., 2007). It is an indigenous breed of the central and eastern parts of Africa and is well adapted to harsh climate and environments with diseases and parasites (Petersen *et al.* 2004). Traditionally in parts of Uganda and Tanzania, Ankole cattle were kept by pastoralists for dual purposes (Wurzinger *et al*., 2006), although the animals were also considered as sacred and kept only for milk and to provide the owners health as it was counted in live animals (Grimaud *et al.* 2007). In past decades these pastoral systems have undergone changes because of the fast growing human population, land shortage and political developments. Thereby many cattle owners have switched from pure pastoralism to mixed crop-livestock farming were Ankole herds are smaller. The smallholder farmers livelihoods are not anymore as depended on livestock as it was in the past since they have other income sources such as crop production or off-farm activities (Wurzinger *et al*., 2006). The change in production systems and increasing demand on milk has put a higher pressure on producers to increase their production. This has increased the use of crossbreeding with high potential exotic dairy cows, which has a considerably higher productivity than pure-bred Ankole cows (Grimaud *et al.* 2007). The important selection criteria of Ankole cows, used by the cattle owners, seem to be milk yield, meat, coat color and body size and those of bulls are coat colour, the information about the bull`s father, horn shape and color of the bull and body size (Wurzinger *et al*., 2006; Ndumu *et al.* 2008; Wurzinger *et al*., 2008). The importance of these traits varies in some extend between different regions and cattle owners.

The impact of horns on productivity in cattle

When comparing the same kind of breeds with and without horns some differences in productivity and body size can be seen. Arango *et al.* (2004) reported significant differences in different traits on Shorthorn and Longhorn cattle, which are two North American breeds. Shorthorn is both heavier and higher and has a higher body condition score than Longhorn. Even milk production is higher in Shorthorn cattle (Arango *et al.*, 2004; Jenkins *et al.*, 2000). These findings in literature indicate that horns have a negative effect on the animal, posing a higher energy need for maintenance and have probably effects on physiology of the animal when comparing with comparable breed with know horns, even though the author, despite the efforts, failed to find literature that directly investigates the impact of horns in cattle.

Understanding the cattle behavior and human-animal interaction

To be able to manage and keep domestic animals, their behavior needs to be understood and partly controlled. This is carried out by physical means such as fences and collars or by actively selecting the desired behavior from the animal's own repertoire and evoking that behavior (Lott and Hart, 1978). Therefore the knowledge about cattle behavior and how to handle it are of great importance.

Understanding the behavior of animals, and how human actions impact on that, is crucial for both animal welfare and productivity as well as for the stock persons' safety and

working conditions (Hemsworth, 2003, Le Neindre *et al*., 1996). Most domestic animals have a natural fear for humans. Grazing animals such as cattle are prey species, and fear motivates them to be alert in order to escape from predators and avoid adverse situations (Grandin, 2007; Rushen *et. al*, 1999). Several studies (Hemsworth *et al*., 2000; Cransberg *et al*., 2000; Waiblinger *et al*., 2002) have shown that the stress caused by fear has a negative impact on productivity and welfare of the animal. Much of the fear arises from handlings that are adverse to the animal.

Without daily positive (not just neutral) interactions with humans the natural fear of humans may appear and have a negative impact on physiology, production and welfare of animals (Rushen *et al*., 1999). It has been shown that careful and intensive handling of *Bos indicus* cattle at early age has a great positive impact on their temperament at later age (Fordyce *et al.*, 1985). Wurzinger *et al.* (2008) describe how the herdsmen managing Ankole cattle massage the animals to make them docile, and groom the cattle to make them used to the herdsmen, and in this way to be easier to handle, especially during the milking. Behavior and attitudes of stock people has also an important impact on cows' behavior and production. Regular handling of cattle decreases subsequent reactivity to humans (Le Neindre *et al*., 1996). Waiblinger *et al*. (2002) found in their study that the use of positive interactions with cows lowered the avoidance distance of humans, and that the positive attitudes and positive characteristics of the stock people had a positive impact on milk yield.

The social and comfort behavior and heard cohesion influences the herd management under extensive open grazing conditions (Huber *et al.*, 2007), thereby affecting both the grazing of the animals and human-animal interaction. In a study done by Wurzinger *et al.* (2008) the cattle owners, who keep Ankole cattle in extensive grazing systems, describe how animals show both friendly behavior such as licking each other and resting together, and agonistic behavior, such as fighting. What it comes to fighting it is the herder's responsibility to separate the fighters (Wurzinger *et al.*, 2008). Cattle have tendencies both to approach and avoid humans. There are differences between breeds; dairy cattle have a shorter flight distance than beef cattle (Murphey *et al*., 1980) mostly because of the difference in production systems in temperate climates where the dairy cows have daily human contact whereas beef cattle are not handled by humans as frequently.

Grazing behavior

In the tropics cattle spend between 60 to 80% of the time on pasture grazing; the frequency varying mostly due to the time of the day, season as well as breed (Bayer, 1990; Langbein and Nichelmann, 1993; Jung *et al*, 2002; Huber *et al*., 2007; Butt, 2010). One factor affecting grazing behavior of cattle in tropical conditions is breed (Blackshaw and Blackshaw, 1994). Breeds of type *Bos taurus* spend less time grazing and in activity and are more affected by heat than breeds of *Bos indicus* type or crossbreeds of these two cattle types (Langbein and Nichelmann, 1993; Bayer, 1990; Blackshaw and Blackshaw, 1994). Seasonality also affects the difference between the breeds. During the dry season Langbein and Nichelmann (1993) found no differences in grazing patterns between a cross-breed of Holstein Friesian (*Bos taurus*) and Cuban Zebu (*Bos indicus*) and pure-bred Holstein Friesian but instead the differences in grazing time were found during the wet season. The pure-bred *Bos taurus* cattle spent less time grazing and increased the time spent in shade more than the cross-bred cattle (Langbein and Nichelmann, 1993). Season has also a great impact on the grazing behavior within one breed. Time spend grazing is relatively low

during the transition period from dry to wet season and in the end of the wet season, and becomes higher during the early wet and early dry seasons (Bayer, 1990). Even grazing pattern differs during the different seasons; the time spent grazing is high during the wet season whereas during dry season the frequency of grazing/walking behavior is high (Butt, 2010) mostly because of the pasture availability and quality, that is during the wet season pasture availability and the forage quality are higher and thereby the grazing behavior is high, whereas during the dry sesason the quantity and quality of the pasture is lower and increasing the compined grazing/walking behavior.

Temperature has a great impact on grazing behavior. Several studies imply that temperatures above 28 ˚C cause a decrease in time spent grazing (Cowan, 1978; Langbein and Nichelmann, 1993; Carvalho *et al.*, 1995). However, when considering the influence of temperature to grazing behavior, there are differences between different cattle breeds as breeds of *Bos indicus* type are more tolerant to higher temperatures than breeds of *Bos taurus* type (Phillips, 2010; Blackshaw and Blackshaw, 1994). Even in periods when temperatures can reach as high levels as 35 ˚C herded cattle of Zebu type can still keep their grazing activity in high level, something that cattle of European origin (*Bos taurus*) cannot (Bayer, 1990).

Restricted grazing time or limited pasture availability can affect grazing behavior and productivity of cattle in different ways. Bayer (1990) found in his study that pastoralists' cattle intensify their grazing activities during daytime and spend more time ruminating and resting during nights at the camp thereby compensating the limited grazing time. The same author states that there are many factors affecting the productivity of the animals in pastoral systems, such as poor quality and availability of pasture, that needs to be taken in account when considering possible negative effects of restricted grazing (Bayer, 1990). In another study (Jung *et al*, 2002) it was found that a prolonged walk to pasture and reduced pasture time reduces the productivity of the cows. The animals did not compensate for the reduced time on pasture by intensifying the grazing activities, although the authors believe that this was probably because of the long walk and the unfavorable weather conditions (Jung *et al.*, 2002). Time spent grazing is also influenced by distance to water (Hart *et al*., 1993), forage availability and tracking by herders (Butt, 2010) hence the amount time spent walking. Herders have a great impact on grazing behavior and pattern of cattle. According to Wurzinger *et al.* (2008) herdsmen lead the animals to the pasture and water, protect them towards wild animals and thieves, docile individuals from aggression by other herd members and take care of sick individuals, those who are in the late pregnancy and the young ones. Herders also decide where and how long the herd will graze, and even where different groups of animals within the herd will graze, that is the strongest and mature cows walk first and get the best pasture, meanwhile the sick, old and the youngest ones come last (Wurzinger *et al*., 2008).

Aim of the study

The purpose of this study was to investigate the grazing behavior of two tropical cattle breeds. One of them, the *Bos taurus/indicus* breed of Ankole, has huge horns whereas the *Bos indicus* breed of Boran cattle has not. The study investigates behavioral and social characteristics and structures in these two breeds and how this can be taken into account in cattle management in commercial farms. Comparing the behavior of the two tropical cattle breeds gives information about characteristics and behavioral adaptations that is needed in

harsh and demanding tropical environments, in particular if the large horns of Ankole cattle restrain grazing behavior and habitat choice and if they change human-cattle interactions.

Material and methods

Study area

The observations were carried out at Ol Pejeta Conservancy in Kenya between 15th February and 22nd February 2014. The methods were tested between 11th February and 14th February 2014 to see which behaviors and habitats should be included in the study and what other conditions should be taken account during the actual data collection. Ol Pejeta Conservancy covers 310 km^2 land area in the Laikipia District of central Kenya at the altitude of about 1900 meters (http://www.olpejetaconservancy.org/sites/default/files/documents/OPCVolunteerProtocol_BeforeArrival.pdf). The vegetation within the conservancy consists of a mix of open grassland, wooded grassland, woodland, and evergreen bush land. The annual mean rainfall is about 72 mm. Usually the rainy season in this area starts in the middle of March, and February is therefore the driest season of the year. However, in the year of this study there had been some rain in January and it also rained during the observations, and therefore the vegetation was of better quality than usually on this time of the year. The maximum temperature in this area is usually between 23-27 ˚C (http://www.audleytravel.com/destinations/africa/kenya/places-to-go/the-laikipia-plateau/ol-pejeta-conservancy/climate.aspx).

Study subjects and data collection

In total 36 cows were observed, of which 18 were Ankole and 18 Boran. The cows were in the same herd, which included 37 Ankole cows, one bull and 19 calves as well as 230 Boran cows but no Boran calves or bulls. All focal cows had calved previously, i.e. none were heifers and were chosen after their phenotype, i.e. the ones that were easiest to identify by color or horns. Lactating cows were excluded to get a more similar focal group. The age of the observed Boran cows varied from 4 to 11 years and in Ankole cows from 3 to 10 years. The state of pregnancy varied between the cows, some of them were at late pregnancy soon to be calving.

Each day six cows of each breed were observed, and the breeds and cows were changed every day between the observers. Observations were done during the morning every day for 5 hours, starting from about 8:30 a.m. when the cows left their night enclosure. They had access to grazing right after leaving the enclosure. Access to water varied between the days but was between 11.30 a.m. and 13.00 p.m. There were two or three herders taking care of the herd, data collection was done by the author and local field assistant, and an armed ranger walked along for security.

Cattle behavior

To understand the time budget of the cows, seven behaviors were chosen to be observed: grazing, browsing, standing, walking, social behavior, running and drinking. The use of shade, that is if the behavior occurred in shade or in sunlight, was also registered to see the effect of heat stress and solar radiation on cattle (see table 1). When testing the methods it was found out that no cows were ruminating or lying down during the morning when the observations were carried out, and therefore these behaviors were excluded from the protocol. Weather and habitat (see table 2 and 3) were also observed to see if these factors had any impact on the behavior; these results were not reliable and will not be presented. Distance between the observed cow and the nearest cow as well as the distance between the nearest herder and the herd were recorded to see how the presence of the herder influences behavior of the cows, and if there was any differences between the herd structures of the two breeds. All these factors and behaviors were observed in 10 minutes intervals. Drinking in each breed was registered whenever it occurred, that is when the first cow of the breed started drinking. Again, the frequency was too low to analyse statistically and no results will be presented here in this paper.

Grazing	Animals standing or walking heads down on pasture
Browsing	Eating leaves from bushes or trees
Standing	Standing still, head up (no walking, running nor grazing)
Walking	Moving forward, not running nor grazing
Social behaviour	All friendly or antagonistic behaviours between the cattle (body contact, licking, grooming, chasing, etc.)
Running	Running, not grazing or walking.
Drinking	Head down drinking water
Shade	More than half of the body is in shade
Sunlight	More than half of the body is in sun light

Table 1. *Recorded behaviour of the cows (interval recordings every ten minutes)*

Open woodland	Bushes and trees higher than 2 meters and the distance between the bushes/trees between 20 and 50 meters
Thick woodland	Bushes and trees higher than 2 meters, and the distance between the trees less than 20 meters
Open bush land	Bushes and trees lower than 2 meters, and the distance between the bushes more than 20 meters but less than 50 meters
Thick bush land	Bushes and trees lower than 2 meters, and the distance between the trees less than 20 meters
Open grassland	The distance between bushes/trees more than 50 meters

Table 2. *Habitat types*

Sunny	The sun is shining, no clouds before the sun, shades clear
Cloudy	The sun is covered by clouds, no shades
Sunny/cloudy	The sun is covered by thin clouds, shades are dim

Table 3. *Recorded weather conditions*

Statistical analyses

The data were analyzed in MiniTab 16 using Anova Analyses of Variance (General Linear Model, GLM) in order to show statistical significances of differences in the observed behaviors, time spent in sunlight and the two distances between the two cattle breeds as well as to see how the observed factors varied over observation time.

Results

Grazing behavior

Both breeds spent most of their pasture time grazing. The frequency of grazing or walking did not differ between the breeds (Table 4). Time spend standing was higher in Ankole cattle than in Boran.

	Grazing	Walking	Standing	Browsing	Social	Running	Drinking
Ankole	63.2 ± 1.5	30.1 ± 1.4	4.9 ± 0.8	0.6 ± 0.2	0.0 ± 0,0	0.6 ± 0.2	0.6 ± 0.2
Boran	66.1 ± 1.7	30.1 ± 1.6	2.0 ± 0.5	0.9 ± 0.5	0.1 ± 0,1	0.4 ± 0.2	0.5 ± 0.2
p-value	n.s.	n.s.	0.001	n.s.	n.s.	n.s.	n.s.

Table 4*. The mean frequency (% of observations ± SE) of different behaviors and p-values for the differences between the two breeds*

Also the time spent in dark respective light differed between breeds (Table 5). The different behaviors however did not differ significantly, except the frequency of being in light. Ankole tended to spend more time grazing and spent more time standing in dark compared to Boran cows. The frequency of grazing in light tended to be higher in Boran than in Ankole.

	Grazing in light	Grazing shade	Standing in light	Standing in shade	Being in light
Ankole	62.1 ± 1.6	1.1 ± 0.3	4.7 ± 0.7	0.2 ± 0.1	98.4 ± 0.4
Boran	65.7 ± 1.7	0.4 ± 0.2	2.0 ± 0.5	0.0 ± 0.0	99.5 ± 0.3
p-value	0.074	0.059	0.003	n.s.	0.03

Table 5*. The frequency (% of observations ± SE) of different behaviors in light and shadow and time spent in light for both breeds. P-values for differences between the two breeds.*

Distribution of different behaviors over time

The cattle were observed for five hours every day. There are significant differences in the distribution of different behaviors over time (Figure 1). Grazing activity was highest at the second and fifth hour whereas walking was most common at the first, third and fourth hour. Most standing occurred at the fourth hour but also at the first and fourth hour. The only observations of running occurred at the fourth hour.

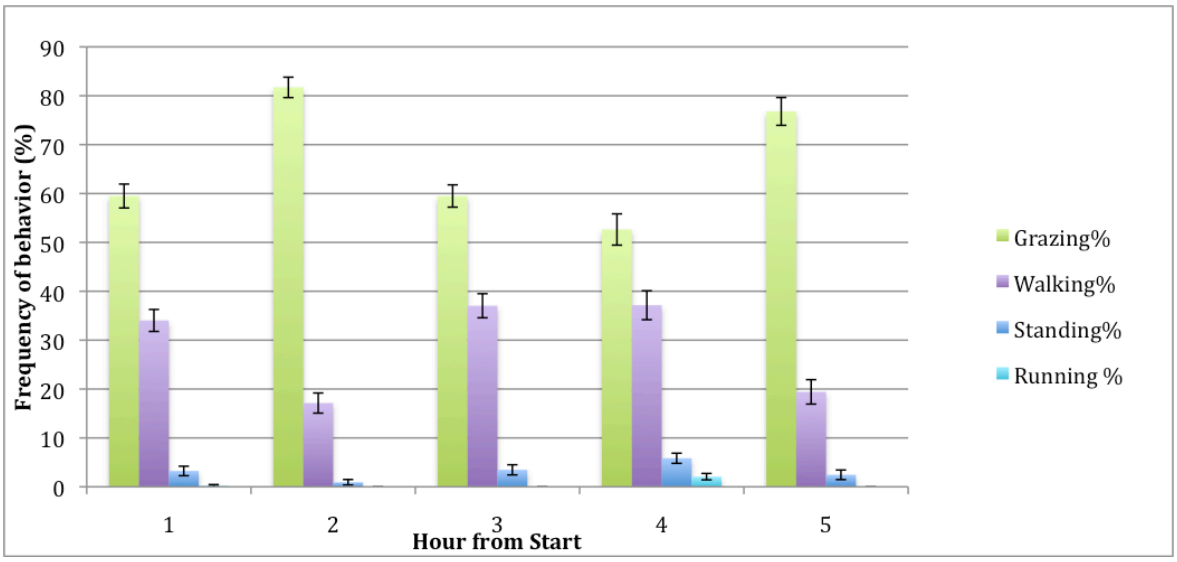

Figure 1. *Distribution of the behavior over the five observation hours. (p-values for differences in the distribution of the different behaviors over time: for grazing: p<0.001, for walking: p<0.001, for standing: p=0.005, for running: p<0.001)*

Time spent in light is highest at the fourth and fifth hour, when no time was spent in shade, whereas at the first, second and third hour some behaviors occurred in shade (Figure 2).

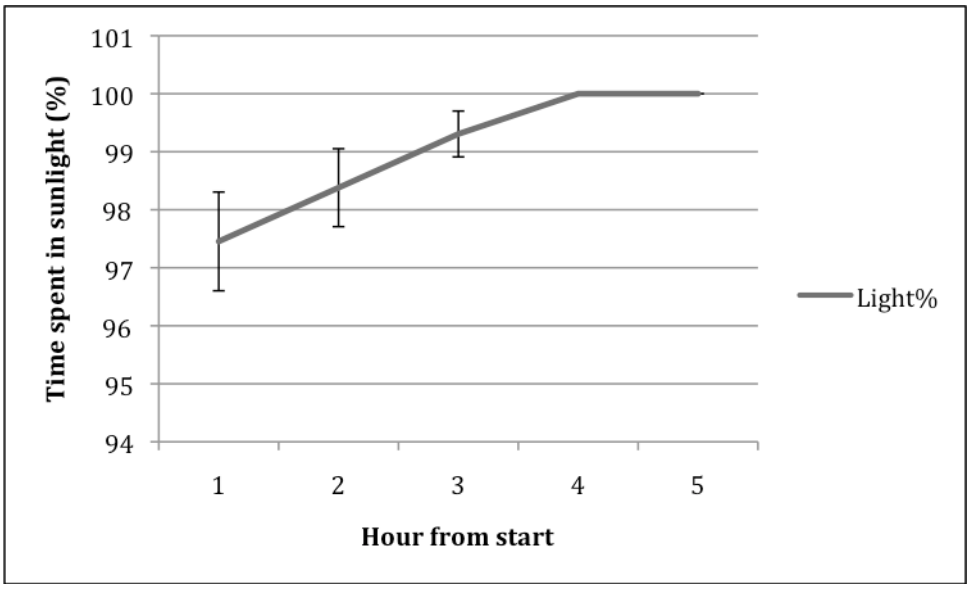

Figure 2. *The time spent in sunlight over the five observation hours (p=0.004).*

Distance C-H and C-C

Ankole cattle had a larger distance to other cows as well as to the herder (Table 6).

	Distance C-H (m)	Distance C-C (m)
Ankole	72.5 ± 3.2	2.2 ± 0.1
Boran	84.6 ± 4.0	1.7 ± 0.1
p-value	0.013	<0.001

Table 6. *Mean distance ± SE between the observed cow and the nearest cow to her, and from the furthest cow to herder. P-values for the differences between breeds.*

The distribution of these distances over time differed to some extent. The distance between the cows was shortest at the first hour and increased to the fifth hour (Figure 3.).

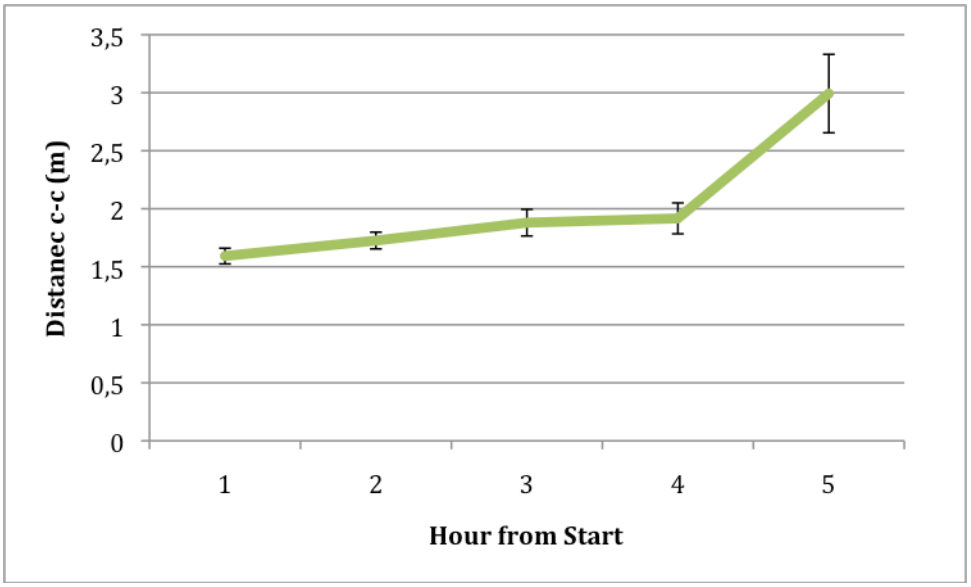

Figure 3*. The distance between the observed cow and the cow nearest to her over the five observation hours.(p<0.001)*

The distance between the herd and the herder was shortest at the second and third hour and highest at the fifth hour (Figure 4).

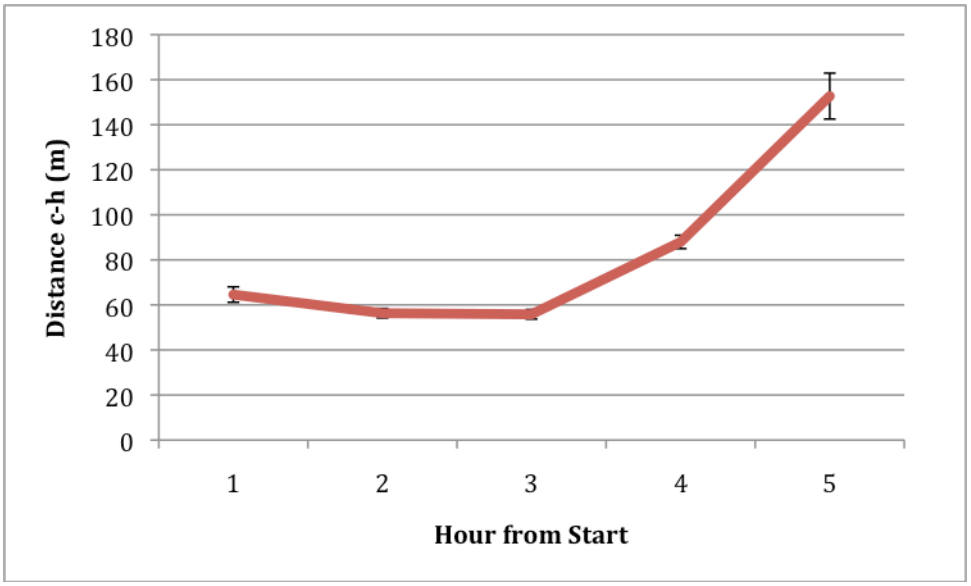

Figure 4*. The distance from the furthest cow to herder over the five observations hours (p<0.001) .*

Discussion

The impact of breed on grazing behavior

The two breeds included in this study are of two different types of cattle, *Bos indicus* and Sanga (a stabilized cross between *Bos indicus* and *Bos taurus*). Boran cattle are of type *Bos indicus* cattle which are known for their good adaptation to tropical conditions, having a high tolerance for heat and solar radiation as well as resistance for many tropical diseases (Hansen, 2004; Phillips, 2010; Blackshaw and Blackshaw, 1994; Carvalho *et al.*, 1995). The same applies for Ankole cattle, which belongs to Sanga group of cattle mainly kept mainly in Eastern and Southern Africa (Rege, 1999). *Bos taurus* breeds of African origin are also well adapted to the warm and humid conditions of the tropics, and are mainly kept in the humid conditions of West and Central Africa (Rege, 1999). They are reported to have a special tolerance for many diseases of tropics and having a lower productivity than zebu cattle (Aboagye *et al.*, 1994). On the bases of literature, both types of cattle included in this study are well adapted in tropical conditions, and therefore only the origin of the breed cannot explain the differences seen in the results but there are other factors contributing to the found differences.

Grazing behavior

Both breeds spent most of their pasture time grazing. Walking and standing were the second and third frequent behaviors. These results agree with several previous studies on cattle grazing behavior in tropical conditions (Bayer, 1990; Langbein and Nichelmann, 1993; Jung *et al.*, 2002; Huber *et al.*, 2007; Butt, 2010). The high frequency of grazing and

low frequency of resting during the pasture time indicates the ability of the cows to adapt their grazing to restricted grazing time, when no grazing is allowed during nights as well as a good adaptation to tropical conditions (Bayer, 1990; Hansen, 2004; Blackshaw and Blackshaw, 1994).

There were no significant differences between the breeds on neither grazing nor walking behavior. The lacking difference between the breeds can partly depend on a synchronize behavior as the two breeds were kept in the same herd, as described by Langbein and Nichelmann (1993). There was, however, a highly significant difference on the frequency of time spent resting. Ankole cows spent more of the pasture time standing than Boran cows, which matches with a previous study on grazing behavior of Ankole cattle (Huber *et al.*, 2007). The difference between the breeds might be because of the large horns of Ankole, which may restrict their grazing and pose a higher need for resting. Ankole cattle have a relatively low productivity when comparing to zebu cattle or European *Bos taurus* cattle (Aboagye *et al.*, 1994; Grimaud *et al.*, 2007). The low productivity can be explained by genetic differences and production potential between the breeds, but also by the large horns that increase energy demands for maintenance, and thereby lowers the productivity when comparing to breeds without horns (Arango *et al.*, 2004; Jenkins *et al.*, 2000).

Many authors have reported that different zebu breeds spent over 4% of their pasture time resting, varying from 4.4 to as high as 10.12 % (Bayer, 1990; Huber *et al.*, 2007; Butt, 2010). There are of course many factors that contributes to the difference between these studies such as season, study area (climate), daytime, breed and study design, but none of these studies record as low as the 2% resting time found in this study on Boran cattle (note that only standing were registered because no lying occurred during the observations). This breed has a high productivity and is used mainly for beef production in Kenya (Wasike *et al.*, 2008). The high frequency of grazing and very low frequency of resting reflects the great efficiency of this breed to utilize and exploit the available resources and time for grazing, that is utilizing the available forage effectively for energy. It is although to be noted that data for this study were collected only during a very short timeframe, and only during the first five hours of pasture time. Therefore the data do not reflect the entire time on pasture and cannot be compared with other studies that observe grazing even during afternoon or night.

The behavior patterns of cattle in tropical conditions seem to differ over time of the day so that during the morning hours grazing frequency is high and declines during the highest temperatures of day, increasing again towards the evening (Langbein and Nichelmann, 1993). In this study, however, the overall grazing was highest during the second and fifth hour, and most walking appeared during first, third and fourth hour. One explanation could be that the vegetation near the night enclosure was mostly rather thick bush land, and there were not that much forage to graze on thereby the grazing behavior decreased because of the poor forage availability, as was reported by Butt (2010). During the first hour herders drove the cattle heavily towards more open land, probably resulting in reduced grazing and increased walking frequency. During the second hour grazing activity was at its top with over 80%. During this hour herders controlled the herd quite intensively allowing the animals to graze, obstructing walking. During the third and fourth hour the cattle were allowed to walk more freely towards the waterhole to drink, decreasing the grazing during these two hours. On the last observation hour the herders let the herd graze freely on open grassland, and thereby increasing grazing frequency again but not on as high level as during

the second hour. That, however, might be because of the hottest time of the day. It seems that herd management has also a great impact on cattle behavior and pattern as will be explained nearer later.

Another explanation of the relative high frequency of grazing during the hottest hours of the day could be that the study area is at quite high altitude and the temperature seldom exceeds 28 ˚C, which is considered to be the critical temperature where above the grazing behavior ceases (Cowan, 1978; Langbein and Nichelmann, 1993; Carvalho *et al.*, 1995). Therefore the grazing behavior might have been influenced more by the herd management than the time of the day and temperature.

Shadow versus light

Both breeds spent most of the pasture time in sunlight, which is clearly logical. During the first three hours the herd was lead through bush- and woodlands where shade was available, but on the fourth and fifth hour the grazing occurred on open grassland where shade was absent. This explains the increasing amount of time spent in light over time, being 100 % on the last two hours.

There have been reports on the time spent in shade, and how it increases during the hottest time of the day (Langbein and Nichelmann, 1993; Tucker et al. 2008). However, the results in this study do not show the same pattern. This is highly dependent on varying habitat of the study area during the observation time. As mentioned before, the vegetation during the first three hours were bush- and woodland varying in thickness, and giving an opportunity for shade. During the fourth and fifth hour, which also were some of the hottest hours of the day, there was no vegetation that could provide shade, and therefore the animals had no choice but to be in direct sunlight. For these reasons the pattern of more time spend in shade during the hottest hours of the day, as described in other studies (Langbein and Nichelmann, 1993; Tucker et al. 2008), could not be seen in this study.

There was, however, a difference in time spent in shade between the breeds: Ankole spent more time in shade compared to Boran cows. When scrutinizing the frequency of different behaviors in sunlight, respectively, shade differences between the breeds could be found, although only standing in light differed. In the literature it is mentioned that Boran cattle has indeed a high tolerance for solar radiation (Wasike *et al*., 2008; DAGRIS, 2014) as though even Ankole cattle is reported to be well adapted to humid and harsh tropical conditions (Petersen *et al.* 2004). It is however notable that in the literature the most important traits by which the animals are chosen differs between these breeds, among those of Boran being tolerance for heat and solar radiation (Wasike *et al*., 2008). These criteria were not ranked as high among the Ankole cattle owners (Wurzinger *et al*., 2006; Ndumu *et al.* 2008; Wurzinger *et al*., 2008), which can be because the cattle owners expect the Ankole cattle to be tolerant to heat nonetheless. One could speculate that selecting the animals by their heat tolerance (Boran) rather than by their beauty (Ankole) has given the Boran cattle a slightly better tolerance for heat and solar radiation. The findings in this study indicate that Ankole cows suffer more of the sunlight radiation, and therefore spent more time in shade compared to Boran cattle. Even here, the huge horns may have impact on the need for more shade on Ankole cattle, as they increase the energy consumption and heat formation. This was in contrast to the hypothesis that Ankole would stay further away from bushes and trees that provide shade, as it would be more unpractical and harder for them to be near the vegetation because of the huge horns. It could, therefore be stated that

despite the huge horns that may hinder the staying in shade, Ankole spent still relatively big part of the pasture time under trees and bushes, and indicating more suffering from the solar radiation. As mentioned above, there were no shade available for the cows during the hottest time of the day, but still the time spent in shade differs between the breeds, and might even be greater if it could be compared during the hottest hours of the day. Here also the differences between the breeds might be clearer if the breeds would graze in separate herds and not be mixed as in this study.

Herd cohesion and structure

The distance between observed cow and the nearest cow to her by every interval were recorded. It was found that Ankole cows spent their time more separate from each other compared to Boran cows. The cows were grazing in their own breed groups the whole time even though they were kept in the same herd. Therefore this particular data is quite accurate and the breeds can be compared. The difference between the cows is probably once again because of the huge horns of the Ankole cows, which prevent them to get close to one another. Herd cohesion and social structures within the herd are very complex as described in literature (Reinhardt and Reinhardt, 1981; Lazo, 1994; Harris *et al.*, 2007) and therefore there are probably many other explanations for the differences between the breeds. The Ankole cattle used in this study has been in the same herd and are grown up together as at the conservancy there is only one herd of Ankole cattle, but Boran cattle are kept in several herds and the cows are transported between the herds. Even the number of the cows per herd can affect the distance between the cows, and thereby even the herd cohesion.

The distance between the cows increased with hours. The cows stayed closer in the beginning when the habitat was mainly thick bush land, and increased the more open the habitat got, being highest at the fifth hour when the habitat was mainly open grassland. The cows probably wanted to stay closer to each other in habitats where they cannot see far away and where the risk for predators is higher.

The impact of herders on grazing behavior

The impact of the herder on the grazing behavior was observed by recording the distance between the furthest cow and the herder for both breeds. The herders were closer to the Ankole cows than to Boran cows. This however is probably because of the different size of the herds. The number of Boran cows was considerably higher than the number of Ankole cows. There was also always one herder for Ankole cows and one or two herders for Boran cows. It was assumed that the herder would stay further away from the Ankole cattle because of the horns and the risk of charging but as one can see it was not the case. It could be seen during the observations, even though it was not recorded, that Ankole cattle in general were calmer and less reactive than Boran cattle, as they were more alert and reactive in the presence of the herders. It has been observed in many studies that positive and regular handling of cattle reduces the fear and reactivity towards humans (Le Neindre *et al*., 1996; Waiblinger *et al*., 2002; Wurzinger *et al.*, 2008; Fordyce *et al.*, 1985). The herd of Ankole cows was quite small and they had a special role at the conservancy as they are mainly kept for tourist and not used for production, as are the Boran cattle. Because of that the Ankole cattle in this case are probably more used to people and are calmer and let the herders come closer than the Boran cows. Le Neidre *et al.* (1996) state in their study that genetic factors significantly affect the handling of the cattle, and thereby one could

speculate that there might even be some genetic differences on temperament of these two breeds.

It should however be mentioned that distance between the furthest cow and the herder was estimated by eye and there were two or three herders taking care of the herd at the same time. This makes it hard to tell how those herders, who were not observed, were located in relation to the cows and which impact did they have on the cows' behavior as well as how accurate the observers' determination of the distance was.

The distance between the cows and the herders increased over time over. This can be explained as follows. At the second hour the distance between the cows and the herder was lowest. At this point the cows grazed most actively. It was the herders who controlled the grazing by restricting the walking and in that way encouraging the grazing of the cattle. During the third hour the walking behavior increased at the expense of grazing. The herders were driving the cows quite actively towards the waterhole, and therefore the distance was short. During the fourth hour when the herd got closer to the waterhole the cows started walking more rapidly, and even the only frequency of running occurred, that is the cows were moving faster than the herders, and were less depend on the presence of them. Therefore the distance between the herders and the herd increased. During the fifth hour the distance between the cows and the herder was highest. At this point the herders lay down on the grass and let the cows graze freely. The grazing activity was high and also the distance to the herder was high, the opposite to the second hour when the distance between the herder and the herd were at its lowest point whereas the frequency of grazing were highest. All these notes and observations, where at some points the herder is close to the herd and controls the behavior (increased grazing/decreased walking or vice versa) and at the other points he lets the animals go freely and the distance is higher (increased grazing/decreased walking or vice versa) contradicts one another.

As these notes are enlightened can following statements be made. The herder has indeed a great effect on the grazing behavior of the cows. Namely it is the herder who decides where the cows are to be grazed, which route they will take to the waterhole and in what pace (Wurzinger *et al*., 2008). They also decide when to let the cows to be more freely; in which point the animals also can more easily choose themselves what behavior to perform. In this study the design was not optimal for these particular observations. To measure the distance between the herd and herder was not a comprehensive estimator on human-animal interactions, especially when hoping to investigate the herder's influence on the grazing behavior. It is namely not only the distance that the herder uses to drive and move the cattle but also different sounds, position, gestures and postures. These methods may even be more important than the distance because the intensively herded cattle get used to people and the presence of the herders (Le Neindre *et al*., 1996), and therefore will not be so affected by just the distance of the herder but they need other ways to communicate with each other.

There is much more to discover and investigate in the human-animal interaction of intensively herded cattle and there is not very much literature available on this subject. This study does cover only a very little part of the complex and multiform relation between the herd management and the grazing behavior of the cattle. It would also require a whole other type of study design and a wider data collection to be able to do further and more accurate conclusions of the human-animal interaction and how it effects the efficiency and productivity of the intensively herder cattle in tropical conditions. It could be also for a

great interest to investigate if the herding increases the feed intake of the cattle compared to free-grazing herds, and thereby also increasing the productivity of the cattle, which could be exploited even in temperate systems during summer pastures.

Conclusions

First it should be pointed out that all the consumptions and conclusions are made with a perception of the short timeframe and the possible flaws in data collection. The findings in this study indicate that the large horns of the Ankole cattle restrict their grazing, which can be seen in lower frequency in grazing respectively higher frequency in resting, and also have an impact on the herd structure, increasing the distance between the cows, when comparing them to another tropical breed, Boran cattle. It seems that Boran cattle use their pasture time effectively for grazing and bearley rests during that time, whereas Ankole cows rest more and spend more of the pasture time in shade when it is available, and thereby seem to be more affected by solar radiation. Not only the horns but also genetic, physical and physiological features of these breeds (in particular in heat tolerance and tolerance to solar radiation) cause the differences in grazing behavior. Lastly it should be noted that this study is to be considered as a pilot study, and further investigation and research needs to be done on this subject.

Acknowledgements

I want to thank the SIDA for the Minor Field Studies-funding that I was provided with for the project, and Ol Pejeta Conservancy for letting me do my study there. I want to address my gratefulness and respect to my assistant during the project, Daniel Naurori, for all his help during the observations and for all the knowledge he shared with me during my time in Kenya. Special thanks to rangers James and Isaac who protected us from buffalos, rhinos, elephants and all other wild life. I would also like to thank all the herders who were so helpful and friendly to me during the observations. And of course Jens, thank you for taking me to Kenya and making this project possible.

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