Behaviour of dairy goats in the collecting area – Influence of space allowance and shape

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1. Introduction

In recent years goat farming has become more and more popular in industrial countries. Part of this development is due to a growing amount of people developing allergic reactions to cow's milk and looking for an alternative milk and milk product supply. Due to goat products still being a niche product on the market as well as delicatessen, they can be sold at a higher price, making goat keeping also interesting from an economic point of view. The demand in Austria is high as are the incentives for farmers to go into goat keeping (Österreichischer Bundesverband für Schafe und Ziegen 2007).

In 2006 a total number of 70,000 goats were housed by 10,000 farmers. Most of these small ruminants can be found in Lower Austria (15,000), Upper Austria (14,000) and Tyrol (14,000). The majority of goat keepers (95%) operate on a more extensive small scale, keeping 60% of the total stock in herds of up to twenty goats. More intensive systems keeping 40% of the total stock in herds of more than 20 and up to 400 animals can be found in those parts of Austria housing the most goats (VIS Jahreserhebung 2006).

It is common practice in Austria to disbud female goats kept for milk production, especially in intensive systems. There are various reasons for disbudding, some of them are that horns are often considered as a risk for injuries and animals might get stuck in fences as well as causing problems in the milking parlour (Mowlem 1988). Nevertheless disbudding has been prohibited by the animal welfare bill, launched in 2005 (1. Tierhaltungsverordnung BGBl. II 485/2004). This caused major discussions among goat farmers and the government responded by modifying the animal welfare bill the following year by allowing disbudding of female goats under certain conditions (e.g. they have to be raised for milk production and it has to be done under anaesthesia by a vet until the age of one month) until the 31st of December 2010 (Änderung Tierhaltungsverordung BGBl. II 530/2006).

In order to find out more about the relationships between housing, horns, social stress and injuries in larger herds until 2010 a research project is carried out at the University of Veterinary Medicine, Vienna, cooperating with the University of Natural Resources and Applied Life Sciences, Vienna. Data collected during those years should provide information for goat keepers allowing them to perform well in a competitive market, advisers and the governmental body deciding on disbudding and associated laws in 2010.

This Master Thesis is part of the data compilation and focuses on social behaviour of horned dairy goats in the collecting area of the milking parlour.

2. Objectives

The aim of this experiment is to find out if space (m^2/animal) and/or shape of the collecting area influences agonistic and socio-positive behaviour of goats and the occurrence of skin injuries. Following hypothesis will be tested:

- Behaviour is influenced by space. More agonistic interactions take place, if less space is available, whereas socio-positive behaviour increases, if more space is available.
- Behaviour is also influenced by shape. Given the same space allowance long and narrow shapes will cause more agonistic interactions, while wider areas allow more socio-positive behaviour.
- Injuries are influenced by space. More injuries will occur, if less space is available.
- Injuries are influenced by shape. Given the same space allowance long and narrow shapes will cause more injuries, whereas in wider area, fewer injuries are encountered.

Furthermore, recommendations on how to design collecting areas to minimize agonistic behaviour and the risk of injuries, according to the results of this experiment, should be provided.

3. Literature survey

3.1. Behaviour of goats

All movements and body positions as well as the results of muscle contraction (e.g. odours and sounds) are part of the behavioural pattern of an animal (Sambraus 1978). These actions can be grouped according to their function.

3.1.1. Social behaviour

The domestic goat (Capra hircus aegagrus) originates from wild goats found in Southwest Asia and Eastern Europe, all of them being social animals.

They live in groups of up to one hundred individuals, whereas herds of twenty are more likely to be found (Sambraus 1978). Shank (1972) recorded even smaller groups of feral goats, the average size ranging around ten individuals. Goats are able to identify each other in herds of up to one hundred animals (Keil 1995), whereas the visual (torso and hind legs, Müller (2006)) and olfactory identification are the most important.

3.1.1.1. Social hierarchy

In a herd ranging around one hundred goats a dominance hierarchy has been found (Keil 1995). Ranks are in general determined by fighting, sometimes by opposing threats (Sambraus 1978) and affected by various factors. Studies revealed contradictory results on this matter (Table1). In some studies weight, horn length, presence of horns, age, temperament, size and milk production were found to influence social rank (Sambraus 1978, Barroso et al. 2000, Keil 1995), whereas others did not find weight, horn length and age to be affecting the social position of goats (Fournier and Festa-Bianchet 1995, Jørgensen et al. 2006).

Table1: PARAMETERS INFLUENCING SOCIAL RANK IN GOATS.

Weight	Horns	Horn length	Age	Temperament	Size	Milk production	Author
+		+	+	+			Sambraus (1978)
	+		+	+	+		Barroso et al. (2000)
+/-		+/-	-				Fournier and Festa-Bianchet (1995)
-			-				Jørgensen et al. (2006)
+						+	Keil (1995)

Social hierarchies are not linear very often, especially when the age difference is minor, complex dominance relationships can be found (Sambraus 1978). Rowell (1974) states that hierarchies only develop in stressful situations and are hardly found or absent in wild groups of goats respectively. In female mountain goats however dominance ranks were found, but they were not stable over time and many reversals in rank occurred (Fournier and Festa-Bianchet 1995). On the contrary linear and stable dominance hierarchies have been described in female mountain goats (Côtè and Festa–Bianchet 2001). Stable, clear and almost linear hierarchies could also be observed in goats kept for milk production (Addison and Baker 1982, Barroso et al. 2000, Keil 1995).

3.1.1.2. Agonistic behaviour

Behaviour, which is performed when two indivuals are fighting, including aggressive and flight behaviour, is according to Immelmann (1982) referred to as agonistic behaviour. Aggressive interactions involve goats fighting and threatening each other as well as defensive behaviour (Immelmann 1982). If an individual doesn't accept its rank or gets within the social distance of a dominant animal, threats will be opposed by the dominant animal. In most cases the subordinate will retreat, if not a fight takes place (Sambraus 1978). Agonistic interactions are often initiated by the subordinate's behaviour (Rowell 1974).

According to its level of aggressiveness, agonistic behaviour can be classified (Collis 1976) into:

- Fight: involving two or more goats (Keil 1995) (Figure1).

  Shank (1972) describes fights between two animals whereas the opponents are facing each other, strike forward and downwards with their heads, make contact with their horns, while their heads are almost on the ground. Before clashing they may also rare onto their hind legs.

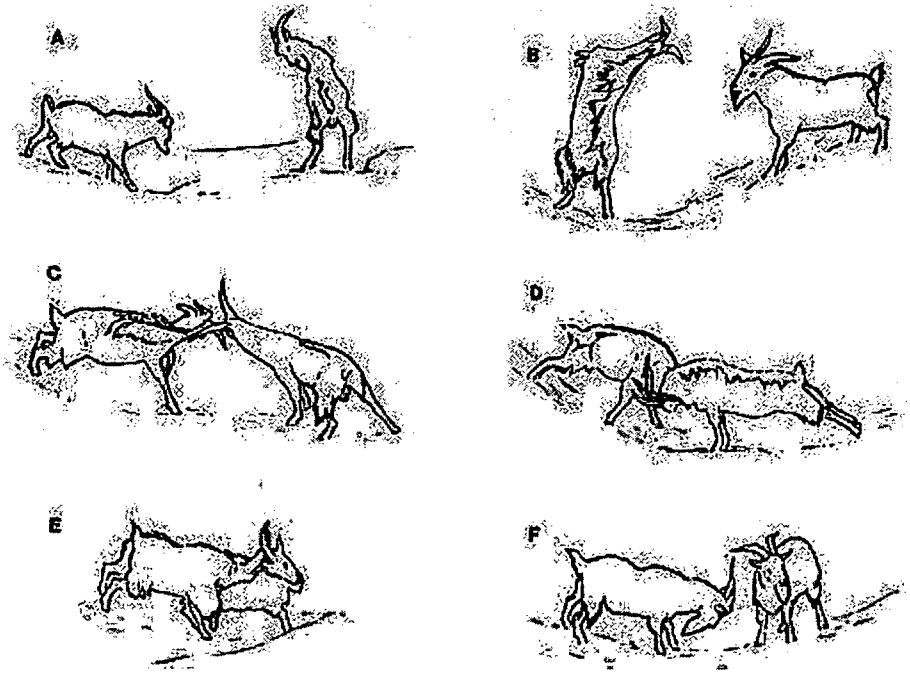


Figure1: ASPECTS OF CLASHING e.g. IN MALE GOATS. (SHANK 1972).

- Butt = attack: head/horns are used by a dominant individual to strike another subordinate animal to drive it away (Keil 1995).

  Biting is also used to drive another goat away. Biting was believed to be only found among naturally polled goats (Sambraus 1978). Tölü and Savaş (2007) however also observed it in horned goats and state that biting is used to control social distance and occurs when there is less opportunity for butting.

- Threat: intention to attack (Keil 1995).

  A wide number of types of threats can be found in goats. If a goat rushes with its' chin tucked in and head low towards another animal or directs its horns towards its opponent, it is referred to as threat (Shank 1972). Chasing, quick upward swings with the head as if leavering out the opponent and biting in the direction of the opponent is also classified as threat.

- Submissive behaviour: avoiding a dominant goat either demonstrating agonistic behaviour or not (Keil 1995).

3.1.1.3. Socio-positive behaviour

Resting in social contact, rubbing, licking and nibbling are considdered socio-positive intereactions and will be reffered to in resting and comfort behavioiurs.

3.1.2. Feeding behaviour

Amongst ruminants, goats can be classified as intermediate feeding types, being able to digest concentrated feed low in fibre as well as grass and roughage containing high amounts of fibre. A very flexible upper lip and tongue allows them to be selective (Mc Cammon – Feldmann et al. 1981) when more forage is available, whereas in times of shortage they behave as generalists (Barroso et al. 2000).

Goats select forage:

- with a higher nutrient content than the rest of the vegetation
- with a beneficial cost/benefit ratio
- favourable to support their body functions, learned by experience
- which is palatable (Krehl 1998).

If pastures are rich, they prefer plant tips and the florescence of gramineous species. If goats have access to bushes and trees, they rare onto their hind legs and crane their necks, trying to feed on as much foliage they can (Sambraus 1978). Excorticated bushes and trees are also common (Krehl 1998) in goat inhabited areas. Their feeding periods are followed by resting and ruminating periods. Rumination takes six to eight hours per day and occurs mostly at night between 8pm and 8am (Sambraus 1978).

3.1.3. Resting behaviour

Goats are resting mostly at night, about 12 hours per day. Rumination allows them only to drowse, due to the fact that a relaxed lateral position would not allow gases, resulting from ruminating, to be released. This is necessary to prevent the rumen content from blocking the stomach entrance (Sambraus 1978). Quiet areas offering good views at the surroundings and shelter are preferred (Bürger 1966); at night inaccessible locations are sought after (Simantke et al. 1994). The hardness of the ground doesn't seem to influence their choice (Simantke et al. 1994) thus thermal conductivity might do (Bøe et al. 2007). At moderate

ambient air temperatures expanded metal flooring is the most and straw the least preferred resting material. The differences between expanded metal or mattress and solid wood or mattress were not significant in these conditions. If the ambient air temperature is low, mattresses and solid wood are the most favoured flooring materials among goats. But also in those conditions no difference between expanded metal and mattress is found (Bøe et al. 2007).

Within their territory goats use often the same resting places to ruminate (Krehl 1998). Often they can be observed resting in groups with body contact (Loretz 2003). If kept inside goats also prefer to rest close to pen walls. Only up to 6% rest in social contact in housed conditions however, according to Andersen and Bøe (2006).

3.1.4. Comfort behaviour

All behaviours having a positive effect on well-being (e.g. skincare, lolling, yawning) are considered comfort behaviour (Sambraus 1978).

Goats are able to reach almost any part of their body either with their horns, hooves or mouth, which according to Simantke et al. (1994) may be a reason why allo - grooming is not frequent. Scratching with the hind legs and horns, licking, scouring and nibbling, respectively using the incisors is observed (Krehl 1998). One of the few social interactions regarding skin care involves two goats rubbing their foreheads or, in case of hornless goats, their horn basis. Parts of the body which are difficult to access (e.g. neck, cheeks) are rubbed against trees, rocks and fence posts (Sambraus 1978). Goats also rub the front part of their body on the ground. This is done by folding in the front legs while chest, shoulders and head have contact with the ground and the hind legs push (Fischer 1978). Shank (1972) mentions goats thrashing bushes or other materials with their horns and also considers it comfort behaviour.

3.1.5. Excretion behaviour

Urine and excrements contain odours, which can contain important information, e.g. in oestrus or kid identification (Grauvogel 1974, Krehl 1998). Goats don't have a particular area for defecation (Grauvogel 1974), but they avoid grazing areas once contaminated with faeces (Buchenauer et al. 1994). The position of females when urinating is a pronounced squat with the hind legs bent and the front legs straight. In male goats, urination can take place in any position without interrupting the activities of the individual. Another type of urination in males includes the extension of the penis, bending of the haunches and extension of the head backwards causing the fluid to hit the mouth, throat, face and beard (Shank 1972). This type of urination plays an important role in reproduction and will be referred to later.

Urination is usually followed by defecation, except the type of urination connected with reproduction. Both sexes hold their tail up during defecation (Sambraus 1978) and don't interrupt their activities as no specific posture is required (Krehl 1998).

3.1.6. Sexual behaviour

The reproduction cycle of goats is seasonal and starts in autumn. The behaviour of the male during this period can be grouped into (Schaller and Laurie 1973):

- spreading of odours

  Odour is produced by sebaceous glands behind the horns and possibly similar glands located in the skin all over the body. The type of urination, where the urine is exerted in

such manner that mouth, throat, face and beard are covered, is found mostly during this period (Sambraus 1978).

- presenting his body attributes
- testing the oestrus of females (Figure2)

The male approaches the female from the rear, licks and smells her perineum, catches some urine when she is urinating or smells the ground, where the urine just impinged. 'Flehmen' follows, in which the upper lip is curled and the head slightly elevated, lips are licked vigorously and yawning may also occur (Shank 1972).

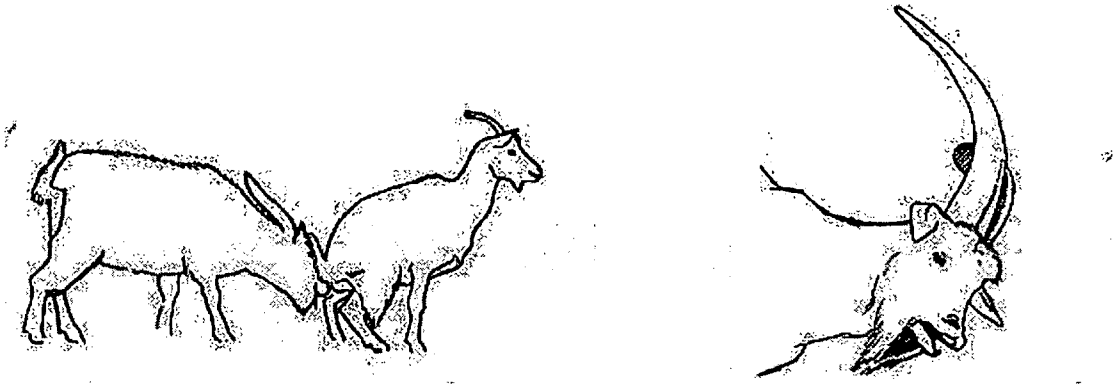


Figure2: MALE TESTS THE OESTRUS OF THE FEMALE BY COLLECTING SOME URINE WHILE SHE IS URINATING. THIS IS FOLLOWED BY 'FLEHMEN', IN WHICH THE MALE CURLS HIS UPPER LIP AND ELEVATES HIS HEAD SLIGHTLY (SHANK 1972).

- courtship of females

The courtship behaviour consists of a sudden lunge at the female from behind or the side. The female might even be pushed forward or just receive a violent thrust of the males head. This is accompanied by a deep guttural moan, flapping of lips and/or flickering of the tongue (Shank 1972).

An anoestrous female responds by ignoring the male and withdrawing from him. If the female replies with vigorous tail wagging and thus possibly spreading sexual odours, the mounting follows. The male approaches from the rare and mounts the female by clasping her with his front legs (Shank 1972).

3.2. Factors influencing behaviour

Various factors affect the behaviour of goats. In scientific studies, emphasis has been placed upon the following aspects.

3.2.1. Size, organisation, shape and location of areas

The size of the feeding and lying space has an impact on agonistic and resting behaviour (Jørgensen et al. 2006, Andersen and Bøe 2006). Jørgensen et al. (2006) found that an increase in number of goats per feeding place leads to significant higher rates of displacement and aggressive interactions. Similar behaviour occurs, when different forages are offered. The rate of aggressive behaviour is significantly higher when hay is offered compared to silage.

A gradual decrease in resting area from 1 m^2 to 0,5m^2 /goat results in shorter resting times and less simultaneous resting. Goats also rest more in the low – comfort activity area when the resting area was reduced (Andersen and Bøe 2006).

If the lying space is organised on two levels, goats demonstrate fewer displacements and the overall aggression level is lower (Andersen and Bøe 2006). This supports Tölü (2005) claiming that biting in goats increases, if the individual distance within the herd is reduced. This is especially the case in narrow areas and goats respond to it by an increased biting frequency (Tölü and Savaş 2007).

With regards to different locations in the housing system, Tölü and Savaş (2007) focussed on biting and butting and observed most biting in the area with the least individual distance amongst the animals, the milking unit. The highest rate of butting however was found on the pasture irrespective of size and shape.

3.2.2. Social rank

A number of authors found that the position of the goat within the herd is connected with its feeding behaviour. In semi – extensive management (grazing during the day and housing in a shed at night) and a good forage supply situation, high ranking goats have the highest intake on shrubs. The consumption of forbs however is least in dominant goats (Barroso et al. 2000). An outstanding feeding efficiency in dominant goats could not be proved among female mountain goats (Fournier and Festa-Bianchet 1995). In more intensive systems and with restricted feeding space allowance, lower ranking goats spend less time feeding (Loretz 2003) and more time queuing. This becomes even more obvious, if the number of goats per feeding place increases (Jørgensen et al. 2006). Müller (2006) states that lower ranking animals are driven away from their feeding place by higher ranking ones and subordinates can only start feeding again once the dominant goats leave.

The social hierarchy within a herd also has an impact on the resting behaviour of goats. Individuals taking up the lowest ranks spend less time resting and also rest less time against the pen wall, whereas resting in the activity area increases (Andersen and Bøe 2006).

Alvarez et al. (2007) claims that in Australian Cashmere goats sexual behaviour is influenced by rank. The incidence of expression of oestrous and concentration of luteinising hormone is higher among dominant goats. Côtè and Festa-Bianchet (2001) found dominant female mountain goats to be more successive in reproduction than lower ranked animals.

Dominant goats also show varying agonistic behaviour, since more butting is recorded in high ranking goats (Tölü and Savaş 2007).

3.2.3. Age and presence of horns

The age of goats affects their agonistic behaviour. Tölü and Savaş (2007) found more biting and butting in goats older than three years than in animals ranging from one and two years of age.

Results of grouping goats at different ages however indicate a tendency of more agonistic interactions in juvenile animals (Müller 2006). Beside the effect of grouping at different ages, Aschwanden et al. (2007) also took social rank, presence of horns and the quality of social bonds into account to test their influence on social distance when animals are feeding side by side. A significant effect on social distance could only be found for the age of grouping and the quality of social bonds (agonistic, neutral or amicable). Juvenile grouped goats with amicable relations fed closest.

Behaviour differs also among goats with horns and naturally polled/disbudded ones (Müller 2006, Tölü and Savaş 2007). In loose housing systems different levels of agonistic interactions in groups of horned goats and goats without horns have been observed (Table2). In this experiment eight groups, à nine goats, have been used, four of them consisted of hornless the others of horned animals. Agonistic behaviour without contact is found more in horned (74%) than hornless (60%) ones. Horned goats oppose 2 times more threats than those without horns, whereas butts directed at the front body parts are 4.5 times higher among hornless animals than horned ones (Müller 2006).

Table2: AGONISTIC INTERACTIONS IN GOATS IN RESPECT OF HORNS IN FOUR GROUPS OF HORNED AND FOUR GROUPS OF HORNLESS GOATS. EACH GROUP CONSISTING OF NINE ANIMALS (MÜLLER 2006).

Behaviour	Horns	Without horns
Agonistic behaviour without contact	74%	60%
Number of threats within agonistic behaviour	61%	31%
Butts directed at front body parts	8%	36%

Furthermore butting is observed more in horned goats than in hornless ones. The rate of biting however, is 2.4 times higher in hornless than horned animals (Tölü and Savaş 2007).

The presence or absence of horns causes also differences in feeding behaviour. In an experimental study the number of feeding places was reduced from 20 to 15 and 10 places. The distribution of hornless goats was more even compared to the horned ones when less feeding space was available. Yet the distances at the feeding rack are smaller between horned goats, due to the fact that low ranking animals spend less time feeding as space is reduced. Number of feeding places also affect overall feeding time, thus it was shorter in groups of horned goats. In this case feeding behaviour is not only influenced by the presence or absence of horns but also dominance hierarchy, which is not as pronounced in polled/disbudded groups according to Loretz (2003).

3.2.4. Changes of group/herd composition

Regrouping of lactating French Alpine goats results in an increase of aggressive behaviour during the first two days after regrouping. Yet milk production is reduced only after the first out of four regroupings, suggesting this breed to be able to adapt to novel situations quickly (Fernández et al. 2007). The introduction of two new animals into an existing group also causes aggressive behaviour to increase (Addison and Baker 1982). Fernández et al. (2007) suggest that new herd members temporarily disrupt the structure of the herd and dominance ranks have to be newly established.

3.2.5. Housing systems and temperature

In loose housing and tethering systems different levels of agonistic and socio–positive interactions have been recorded, respectively. Threatening was three times more frequent in loose housing and the total level of agonistic behaviour was also higher. The highest level of socio-positive interactions was recorded in tethered goats, mostly nibbling and scouring/scratching, which might be due to the goats being bored and trying to engage in some sort of activity (Müller 2006).

Ambient air temperatures can also cause goats to alter resting and feeding behaviour when kept in housing systems. With temperatures around 10°C, goats spent on average 70% of

their time resting, whereas in colder surroundings (-8 to -12°C) resting was reduced to 60% and more time was spent active and feeding (Bøe et al. 2007).

4. Animals, materials and methods

4.1. Experimental conditions

The present study took place at the Institute of Organic Farming (Johann Heinrich von Thünen - Institute, Federal Research Institute for Rural Areas, Forestry and Fisheries) in Trenthorst, Northern Germany. It started on the 30th of June and ended at the 11th of August 2007. The institute is operated as a mixed farming system, including crops, grassland, forest and animal husbandry (dairy cattle, pigs and dairy goats). Eighty employees look after 600 ha of land.

As one of the very few research institutions keeping a herd of horned goats large enough to carry out this study, it was chosen for my project.

4.2. Animals

A flock of sixty-six healthy milking goats (breed Bunte Deutsche Edelziege) in mid-lactation was used for this experiment. Eleven out of sixty-six animals were naturally polled, the others horned. Minimum, maximum and mean values for age, weight, lactation and milk yield for all sixty-six animals are documented in Table3. During the experimental period the hooves of all animals were trimmed once. Biting lice (Trichodectidae) could be found on some animals. Lameness was also documented in some cases.

Table3: AGE, WEIGHT, NUMBER OF LACTATION AND MILK YIELDS OF THE FLOCK USED IN THIS EXPERIMENTAL STUDY.

	Age	Weight (kg)	Lactation	Milk yield (l/day and goat)
Minimum	2	46	1	0.40
Maximum	7	72	6	2.40
Mean	4	58	3	1.30

4.3. Housing conditions and management

During winter the goats are kept in a loose housing system (fully deep litter) including an outdoor loafing area with concrete flooring they have access to at any time. The west and also loafing area facing wall partly consists of fine mesh allowing ventilation and blinds to influence the temperature inside the barn. A wooden resting area, littered with straw, where the goats can choose between three levels, is located on the south side. Straw is used as litter material and two hay racks provide hay at libitum. Two drinking troughs, several mineral blocks and two concentrate feeders each with two access sites to feed. These feeders operate electronically, allowing each goat a certain quantity according to her milk production, are part of the housing equipment. The concentrate is a mixture of crushed oats, wheat, peas and beans. The consumption of concentrate per goat is on average one kilogram per day.

The pastures the animals have access to between spring and autumn are located close to the barn and rotated frequently. Roofed trailers provide shelter, water and concentrate is offered in troughs. During the experimental period the goats spent most of their time on the pasture.

The rectangular shaped collecting area provides 0.5m²/animal. The milking takes place in a side by side milking parlour, with one side operating and ten cups on each side, measuring the milk quantity per goat and milking. The same type of concentrate, which is given in concentrate feeders and fed on the pasture, is also fed in the milking parlour. Usually nine goats are taken in at once and all returned to the flock no later than twenty minutes. As the milking is done in shifts, different persons (experienced and on training) were milking during the study period.

The daily routine of a goat, including the experimental period, is found in Table4.

Table4: DAILY ROUTINE FOR THE HERD OF GOATS, WHICH WERE PART OF THE EXPERIMENTAL STUDY.

Time	**Activity**
5:30	goats are collected from the pasture, if they have been outside, and transferred to the barn
5:45	goats go into the collecting area
6:00 – 8/8:30	Milking
8:30	animals go back to the barn
9:00	goats are brought to the pastures and fed concentrate, in case of rain they stay inside
15:00	goats are collected from the pasture, if they have been outside
15:45	goats go into the collecting area
16:00 – 18/18:30	Milking
19:00	goats are brought to pasture and fed concentrate, in case of rain they stay inside

4.4. Experimental design

The herd was randomly assigned, balanced for age, weight, lactation and milk yield, in two groups at the 20th of June 2007. These two groups had access to seperate areas in the barn and the pastures during the experimental period. One concentrate feeder and hay rack was provided for each group, the wooden resting area was only available for one group during the experimental period. One group included six naturally polled goats, the other one five out of thirty three animals. The animals were marked individually on their flanks and back with numbers ranging from one to thirty three using hair dye. Groups were additionally marked with green and blue dots, respectively. Three different experiments were carried out in the collecting area, providing different shapes and space allowances. Already existing gates and elements, consisting of metal frames and vertical metal bars filling the frames, fixed to the ground with wooden planks, where used to build the outline of the experiments. Each experiment was applied for two weeks, including the cross over of the two groups within the experiment (Table5).

Table5: START, END AND DURATION OF EACH EXPERIMENT.

Experiment	Start/End	Date
Experiment 1	Evening milking	30.06.2007
	Morning milking	07.07.2007
cross over	Evening milking	07.07.2007
	Morning milking	14.07.2007
Experiment 2	Evening milking	14.07.2007
	Morning milking	21.07.2007
cross over	Evening milking	21.07.2007
	Morning milking	28.07.2007
Experiment 3	Evening milking	28.07.2007
	Morning milking	04.08.2007
cross over	Evening milking	04.08.2007
	Morning milking	11.08.2007

4.4.1. Experiment 1

In this experiment the influence of space was tested, allowing 0.4m² and 0.7m² per animal, respectively by providing a wide and rectangular basic shape. During the first week (Figure3) 0.4m²/goat was offered to group one and 0.7m²/goat to group two; this was then changed during the second week of experiment 1 accordingly.

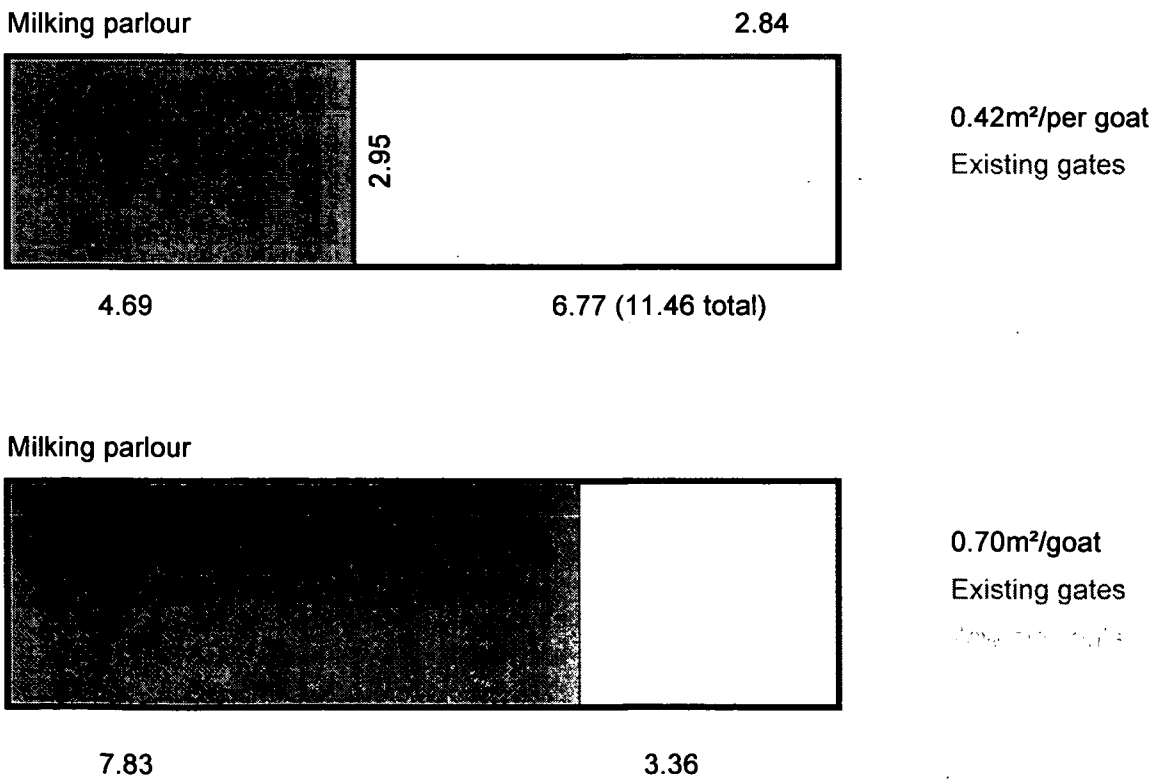


Figure3: EXPERIMENT 1. LAYOUT OF THE COLLECTING AREA – THE GREEN AREA REPRESENTS A SPACE ALLOWANCE OF 0.42 m²/ANIMAL, THE BLUE AREA OF 0.70m²/ANIMAL. ALL MEASUREMENTS ARE IN M.

4.4.2. Experiment 2

This experiment also tested the influence of space. The space allowance per animal in experiment 2 is the same as in experiment 1 (0.4m²/0.7m² per goat), but the basic shape was different. During the first week (Figure4) a long and narrow area with 0.4m²/goat for group one is provided while group two is offered a similar shape with 0.7m²/animal, vice versa during the second week of experiment 2.

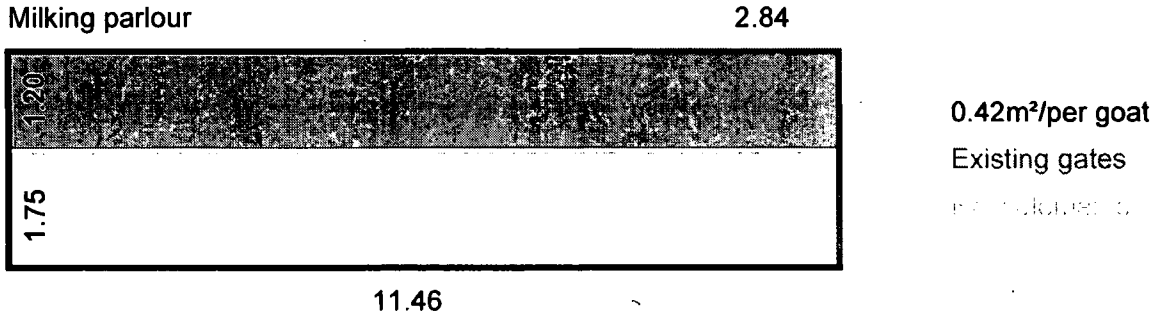


Figure4: EXPERIMENT 2. LAYOUT OF THE COLLECTING AREA – THE GREEN AREA REPRESENTS A SPACE ALLOWANCE OF 0.42 m²/ANIMAL, THE BLUE AREA OF 0.70m²/ANIMAL. ALL MEASUREMENTS ARE IN M.

4.4.3. Experiment 3

In this experiment the space allowance is the same for both groups (0.4m²/goat), but the shapes are different. During the first week of experiment 3 (Figure5) the collecting area for group one is long and narrow, as it is more square shaped for group two, vice versa during the second week.

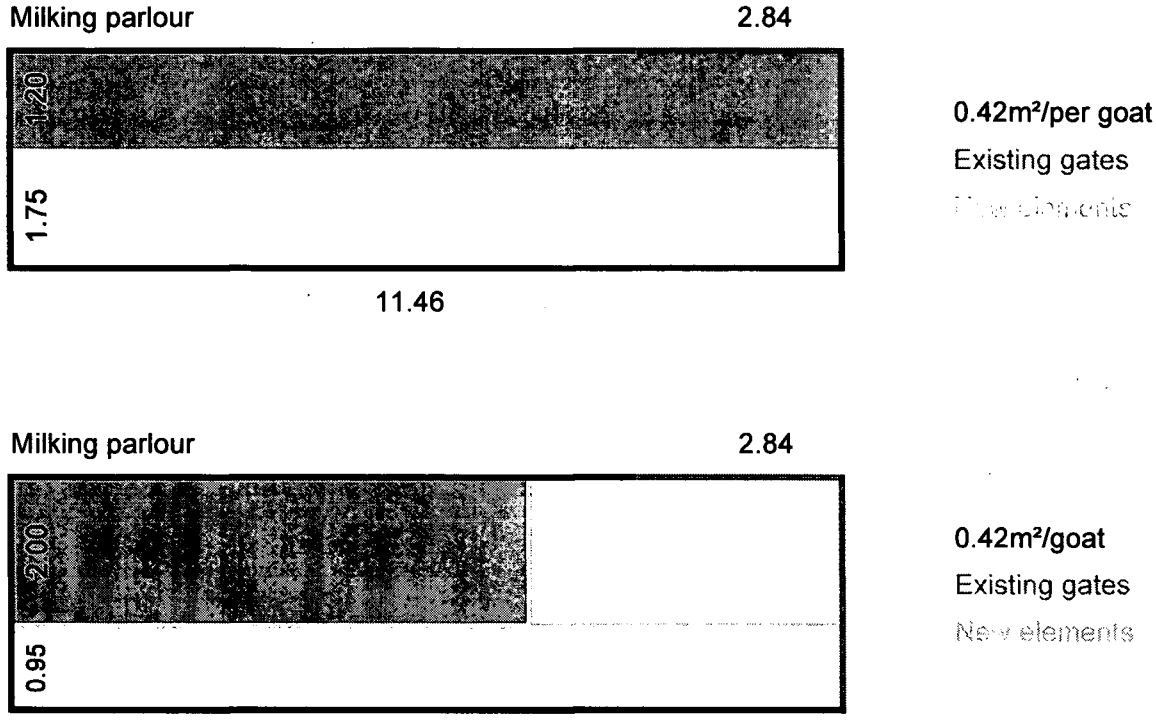


Figure5: EXPERIMENT 3. LAYOUT OF THE COLLECTING AREA – THE GREEN AREA REPRESENTS A LONG AND NARROW AND THE BLUE AREA A MORE SQUARE SHAPED COLLECTING AREA. ALL MEASUREMENTS ARE IN M.

4.5. Behavioural observations

The animals were observed in the collecting area on five days of the week of the current experiment using continuous behaviour sampling. This included the evening milking on the first day, the morning and evening milking on the third, fifth, sixth, seventh day and the morning milking at the eighth day. Observations took place from a position outside the collecting area, trying to avoid any influence on the goats' behaviour by the observer. Interactions as defined in Table6 and Table7 were continuously recorded and for each event the actor and the receiver was noted down; at very active periods only the type of behaviour was recorded.

Group one was first brought into the respective part of the collecting area (Figure6). After fifteen minutes of observing the waiting animals, the door to the parlour opened and the milking began. The behaviour occurring during these fifteen minutes was documented in five minute periods, 0-5 (W1), 5-10(W2), 10-15(W3) minutes. The observation continued during the full milking process until the last animal went into the milking parlour. Interactions during the milking period were also documented in periods. The closing of the door to the parlour after the goats went inside, at the beginning of the milking indicates the start of 'M1' and the opening for the second lot to go into the pit the end of 'M1'. 'M2' and 'M3' also start when the door closes, 'M2' ends when it opens again whereas 'M3' ends when all animals walked into the milking parlour. The number of animals in the collecting area ranged between thirty three during the waiting period, twenty four after the first lot of nine goats went into the milking unit, fifteen after the second and six after the third turn. At the end it was only six goats being milked at the time.

After preparing the collecting area for the second group, group two, the same procedure as for group one was carried out (Figure6)

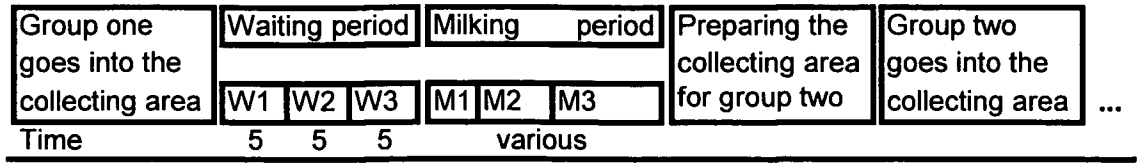


Figure6: WORKING/OBSERVATION ROUTINE IN THE COLLECTING AREA WHILE THE EXPERIMENTAL STUDY TOOK PLACE. THE DURATION OF THE MILKING PERIOD VARIES ACCORDING TO THE MILKING SPEED OF THE MILKERS. TIME IS GIVEN IN MINUTES.

Table6: DEFINITIONS AND CODES FOR AGONISTIC BEHAVIOUR (MODIFIED AFTER SHANK 1972):

Code	Behaviour	Description
C2	clash 2	Two goats face each other and strike forward simultaneously, making contact either with their foreheads or horns. One or both goats may rear onto their hind legs before clashing.
C1	clash 1	Two goats face each other and one forward, contacting the other goat either with her forehead or horns. The initiating goat may rise onto the hind legs before accomplishing the clash.
PF	push (frontal)	Two goats are touching at their foreheads/horn basis, exert pressure and change their location while doing so.
PL	push (lateral)	One goat pushes the neck or side of another goat with her forehead/horn basis.
BT	butt	A goat hits any part of the body of another goat with her forehead/horn basis, except the head. If the attacked goat does not retreat the butt has been documented as not successful (BTx).
K	kick	A goat performs a quick upward swing with her head and hits another one with the end of her horns. All extremities of the other goat stay on the ground. If the attacked goat does not retreat the kick has been documented as not successful (Kx).
LO	lever out	A goat performs a quick upward swing with her head, hits another one with the end of her horns and levers her out. At least one extremity of the attacked goat looses contact to the ground.
T	threat	A goat directs her horns, moves her head (forwards or backwards) or body quickly towards another goat or indicates biting. All movements are made without body contact.
C	chase	A goat chases another fleeing goat more than the body length of a goat.

I	interference	A goat interferes in a fight or play of two other goats with socio - negative behaviour. Type of socio – negative behaviour is documented.
A	arbitrate	A goat joins a fight or play of two other goats without socio - negative behaviour by placing herself between them.
M	mount	A goat mounts another one from the rear or side.
B	bite	A goat bites another one at any part of the body, except the udder, tail and vulva/anus. If the attacked goat does not retreat the bite has been documented as not successful (Bx).
BU	bite (udder/teats)	A goat bites into the udder/teats of another goat.
BL	bite (tail)	A goat bites into or pulls the tail of the other goat.
D	displacement	A goat displaces another one without body contact.
F	fight	Includes two goats and involves the interactions clashing and pushing. A fight ends, if one individual shows its inferiority or walks away.
FG	group fight	Includes more than two goats and involves the interactions clashing and pushing. A group fight ends if one individual shows its inferiority or walks away.
R -	rub	A goat rubs her head/horns at the body (not head) of the other goat which tries to escape or retreats.
RT	rouse (without body contact)	A goat rouses another one by threatening her.
RB	rouse (with body contact)	A goat rouses another one by butting her with her forehead/horn basis.

Table7: DEFINITIONS AND CODES FOR SOCIO–POSITIVE BEHAVIOUR.

Code	Behaviour	Description
PF	play fight	It involves the same interactions as 'fight' but none of the goats leave the ground and/or shows her inferiority at the end.
HO	horning	Goats are facing each other, having contact with their horns or horn basis and exerting pressure, without changing their location.
LA	lean against each other	A goat leans with her forehead against the body (except the head) of another goat for at least ten seconds at the time.
L	lick, nibble	A goat licks or nibbles at the body of another goat (except the vulva or anus) using her tongue, teeth or lips.

RH	rub (head)	Two goats are rubbing their foreheads/horn basis.
RR	rub (body)	A goat rubs her forehead/horn basis at the body of another goat (except head).

4.6. Scoring of injuries

During the first and the last milking of every experiment including crossover, the animals were examined in the milking parlour. It was done by the same person using a tape measure, a mirror and a torch. Some injuries were documented by camera. All visible injuries were noted down (Table8), whereas the head and neck area were not examined.

Table8: CATEGORIES OF INJURIES.

Type of injury	wound
	turgor
	Other (e.g. scars, pustules)
Surface	Blood
	Scab
	red/inflamed
	hair loss without sign of inflammation
Severity of turgor	Slight
	medium
	severe
Size (cm)	length
	diameter
Location	Flank
	abdomen
	udder
	extremities

4.7. Statistical analysis

4.7.1. Behaviour

Data were transferred to Excel and pivot charts were used. The interactions observed were pooled into behaviour classes (Table9). In case of 'interference', socio–negative behaviour is not documented, as it was found very rarely. This also applies to 'fight' and 'play fight', which is documented in terms of single interactions and not as 'fight' and 'play fight'. Once a goat roused another one by clashing, which is marked as 'rouse with body contact'. The behaviour 'rub' (R-, RH, and RR) and 'displacement' were excluded from analysis in all experiments, as they are regarded passive behaviours.

Table9: INTERACTIONS OBSERVED AND MERGED IN BEHAVIOUR CLASSES.

Behaviour class	**Interactions**
positive	HO LA L RR
clash	C2 C1
kick	K LO
bite	B BL
threat	T
butt	BT BTx
agonistic total	C2 C1 RT RB K LO B BL T BT BTx I PF PL C

The experiments 1, 2 and 3 including their respective behavioural classes, were analyzed separately with SAS 9.1 © 2003. Since time might influence the behaviour of the goats over an experimental period of six weeks the experiments were not compared. Data on group level (n=2) was used, waiting and milking periods were analyzed in total, whereas data from observations on the first and eighth day were excluded from linear mixed model analysis.

The linear mixed model was based on following class variables:

Treatment (t): 0.4/0.7m² per goat in experiment 1 and 2, long/square in experiment 3

Day (d): 3, 5, 6 and 7

Group (g): group one or two

Sequence (s): treatment order of the two groups, 1 or 2

Milking time (m): morning and evening milking

Treatment*milking time (t*m): interaction between treatment and milking time

The behavioural classes were defined by t + d + t*m + s + m, 'group' was treated as a random effect. To improve residual distribution some behavioural groups were transformed (Table10). For significant factors (alpha 0.05) least square means and standard errors were calculated using original data, whereas p-values were calculated using transformed data.

Table10: TRANSFORMATION OF THE BEHAVIOURAL GROUPS FOR THE WAITING AND MILKING PERIOD.

Waiting period	**Experiment 1**	**Experiment 2**	**Experiment 3**
positive	-	-	-
clash	-	-	-
kick	+0.1, square root	square root	+0.1, square root
bite	+0.1, square root	-	-
threat	log	log	log
butt	square root	square root	square root
agonistic total	log	log	log

Milking period			
positive	-	-	-
clash	-	-	-
kick	+0.1, square root	square root	+0.1, square root
bite	-	-	-
threat	Log	log	log
butt	Log	log	log
agonistic total	Log	log	log

Furthermore the frequency of 'agonistic total' was calculated using descriptive data analysis. The waiting period was analyzed in five minute intervals (W1, W2 and W3) and the milking period was also analyzed in intervals (M1, M2 and M3). As for statistical analysis the experiments were taken into account separately, data on group level was used and the first and eighth day excluded. Within the experiments some data has been excluded due to missing interval documentation and irregularities in the milking process (Table11).

To be able to compare the outcomes all data have been calculated in behaviour per animal and hour.

Table11: EXCLUDED DATA FOR FREQUENCY ‚AGONISTIC TOTAL' CALCULATION.

Experiment	Week	Day	Milking time	Group	Excluded period
1	1	6	morning	one	waiting period
1	2	5	morning	two	waiting period
1	1	1	evening	one	milking period
1	1	1	evening	two	milking period
1	1	3	evening	one	milking period
2	1	3	evening	one	waiting period
2	1	1	evening	one	milking period
3	2	1	evening	one	waiting period
3	1	3	evening	one	milking period

4.7.2. Injuries

All data were transferred to Excel, whereas in case of one missing category e.g. location, surface or size, the injury was not transferred. For descriptive analysis only 'fresh injuries' (injuries with a bloody surface) were taken into account.

5. Results

5.1. Behaviour

A total number of 11,300 interactions were analyzed, whereof 50% was threatening (5,760), 33% butting (3,880) and 8% (870) kicking behaviour. Socio-positive interactions were observed on a very low level (<1%).

5.1.1. Experiment 1

In this experiment a significant influence of space allowance (0.4 and 0.7m²/goat, respectively) was found on most of the agonistic behaviours. The interaction between treatment and milking time did not have a significant effect on any of the behavioural groups.

During the waiting period space allowance was found to have a significant effect on threatening, butting and total agonistic behaviours (Table12), which were observed significantly more often when less space was available. Goats performed 1.5 times more threats (6/4 interactions/animal and hour), butts (3/2 interactions/animal and hour) and total agonistic behaviours (11/7 interactions/animal and hour) during the waiting period, if 0.4m²/animal were allowed compared to 0.7m²/animal. Goats also interacted more frequently during the evening milkings when 0.4m²/goat were allowed, however the differences where not significant (Table12). On the contrary, socio-positive behaviour occurred more often on a very low level, if more space was allowed (0.4/0.7m²: 0.04/0.11 interactions/animal and hour; not significant).

A similar pattern was found for the milking period (Table12). In addition to more prevalent behaviours significantly affected during the waiting period ('threat', 'butt' and 'agonistic total') kicking and clashing interactions, both occurring hardly more than once per animal and hour, were also found to be significantly affected by space allowance. LS-means for kicking and clashing increased 2 and 6 fold, if less space was available (0.4/0.7m²: 1.8/0.9 butting and 0.2/0.03 clashing interactions/animal and hour). Threatening, butting and overall agonistic behaviour were found to occur almost twice as much in small (6/3 agonistic interactions/animal and hour) compared to larger collecting areas. Most interactions also increased, when less space was available in combination with evening milkings, e.g. clashing (Table12). The animals tended to carry out more socio-positive behaviour in the morning and when more space was allowed.

The level of social interactions in the collecting area was generally higher when goats were waiting before milking compared to the milking period (Table12). Goats showed about 50% less overall agonistic behaviour (6/11 interactions/animal and hour), threats (3/6 interactions/animal and hour) and butts (2/3 interactions/animal and hour) during milking compared with the precedent waiting period.

Table12: EXPERIMENT 1 - LEAST SQUARE-MEANS (LS-MEANS), STANDARD ERRORS (SE) AND P-VALUES (p) ARE GIVEN FOR ALL BEHAVIOURAL GROUPS FOR THE WAITING PERIOD AND MILKING PERIOD. LS-MEANS REFER TO TREATMENT (0.4/0.7m² PER GOAT) AND TREATMENT*MILKING TIME (e-EVENING, m-MORNING) AND ARE GIVEN IN INTERACTION PER ANIMAL AND HOUR.

Behaviour	**Treatment**				**Treatment*milking time**					
Waiting period	**0.4**	**0.7**	**SE**	**P**	**0.4 e**	**0.4 m**	**0.7 e**	**0.7 m**	**SE**	**p**
positive	0.04	0.11	0.061	0.164	0.00	0.09	0.11	0.12	0.070	0.482
clash	0.22	0.16	0.050	0.417	0.29	0.15	0.17	0.15	0.070	0.370
kick	0.89	0.66	0.154	0.505	0.95	0.83	0.85	0.47	0.218	0.579
Bite	0.33	0.12	0.085	0.065	0.41	0.24	0.15	0.09	0.110	0.686
Threat	5.93	3.88	0.540	0.023	5.85	6.00	4.35	3.41	0.764	0.427
Butt	3.18	2.11	0.509	0.014	3.38	2.98	2.35	1.86	0.575	0.807
agonistic total	10.57	6.95	1.080	0.012	10.93	10.21	7.88	6.03	1.416	0.487
Milking period										
Positive	0.11	0.19	0.079	0.301	0.06	0.17	0.08	0.30	0.094	0.491
Clash	0.18	0.03	0.027	0.001	0.26	0.09	0.05	0.01	0.039	0.069
Kick	0.82	0.40	0.228	0.035	0.97	0.68	0.52	0.27	0.274	0.796
Bite	0.07	0.03	0.023	0.188	0.04	0.10	0.04	0.02	0.032	0.264
Threat	2.56	1.41	0.322	0.006	2.72	2.40	1.59	1.23	0.456	0.948
Butt	1.75	0.91	0.272	0.017	2.00	1.49	1.20	0.61	0.385	0.407
agonistic total	5.51	2.79	0.723	0.004	6.10	4.93	3.42	2.16	1.023	0.591

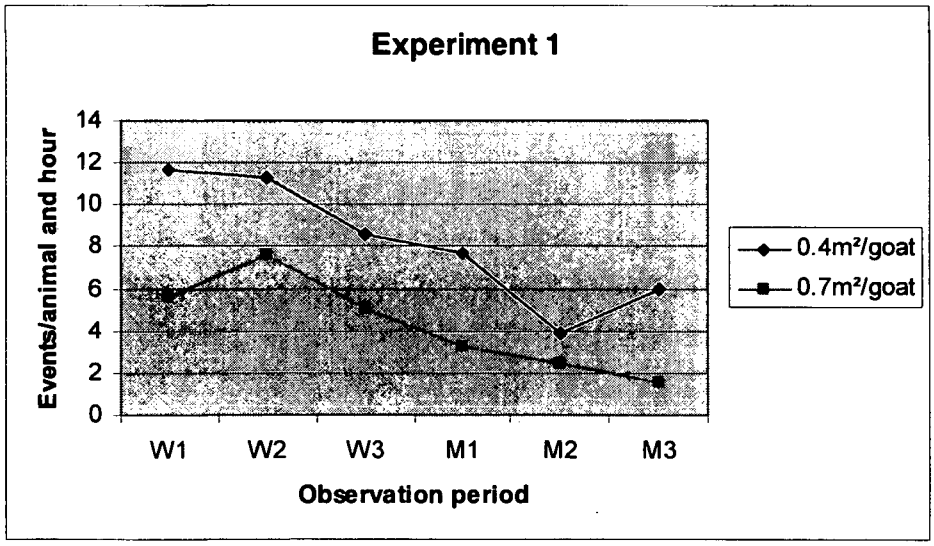


Figure7: FREQUENCY OF 'AGONISTIC TOTAL' (INTERACTIONS PER ANIMAL AND HOUR) IN EXPERIMENT 1 DURING DIFFERENT TREATMENTS (0.4/0.7m²/GOAT) IN THE TIME COURSE OF THE OBSERVATIONS (W1, W2, W3: 5 min PERIODS DURING THE WAITING PERIOD; M1, M2, M3: PHASES DURING MILKING)

The frequency of agonistic interactions increased, when 0.4m²/animal was available (Figure). A marked decrease took place when there were less animals present during the milking period. During the waiting period it ranged between 9 and 12 interactions/animal and hour, when less space was allowed and between 5 and 8 interactions/animal and hour when goats had access to a more spacious collecting area. During the milking period animals were found to interact between 4 and 8 times/animal and hour in a small collecting area whereas in a larger collecting area goats interacted 2 and 3 times/animal and hour.

5.1.2. Experiment 2

A significant influence of treatment (0.4/0.7m² per goat) was found on several behavioural classes, whereas the interaction between treatment and milking time had a significant effect on one behavioural class.

During the waiting period almost all behaviour classes occurred significantly more frequent when less space was available. The levels of interactions were twice (e.g. 'threat' 6/3 interactions/animal and hour, 'agonistic total' 11/5 interactions/animal and hour) and in case of the hardly occurring behaviour of biting six times (e.g. 'bite' 0.5/0.08 interactions/animal and hour) as high if 0.4m²/ goat were available compared to 0.7m²/animal. A significant effect of treatment*milking time was found for kicking behaviour, whereas goats interacted most when they had access to a smaller collecting area and were milked in the morning. The lowest level of kicking was calculated for 0.7m²/goat and morning milkings (Table13). Regarding other behavioural groups no clear trend on treatment and milking time could be found. More space was found to significantly enhance socio-positive behaviours (0/0.04 interactions/animal and hour), however on a very low level.

Once the milking started, more prevalent behaviours such as (Table13) threatening, butting and agonistic interactions in total significantly occurred 1.5 times more often in smaller than in larger collecting areas (e.g. 'butt':, 0.4 m²/goat - 1.4 interactions/animal and hour, 0.7 m²/goat - 2 interactions/animal and hour). Goats were in general found to interact more, if less space was allowed. They also interacted more frequently during most evening milkings e.g. 'agonistic total', if the collecting area was smaller, thus none of these differences was significant (Table13). Animals seem to carry out more socio-positive behaviour when more space was available (0.4m²/goat - 0.03 interactions/animal and hour, 0.7m²/ animal - 0.06 interactions/animal and hour).

Goats performed more agonistic behaviour during the waiting than the milking period (Table13). The three behavioural groups occurring most frequently (threat, butt, agonistic total) decreased by about 50% during the milking period.

Table13: EXPERIMENT 2 - LEAST SQUARE-MEANS (LS-MEANS), STANDARD ERRORS (SE) AND P-VALUES (p) ARE GIVEN FOR ALL BEHAVIOURAL GROUPS FOR THE WAITING PERIOD AND MILKING PERIOD. LS-MEANS REFER TO TREATMENT (0.4/0.7m² PER GOAT) AND TREATMENT*MILKING TIME (e-EVENING, m-MORNING) AND ARE GIVEN IN INTERACTION PER ANIMAL AND HOUR.

Behaviour	**Treatment**				**Treatment*milking time**					
Waiting period	**0.4**	**0.7**	**SE**	**p**	**0.4 e**	**0.4 m**	**0.7 e**	**0.7 m**	**SE**	**p**
positive	0.00	0.04	0.011	0.022	0.00	0.00	0.05	0.03	0.015	0.625
clash	0.09	0.02	0.018	0.013	0.08	0.11	0.03	0.02	0.025	0.374
kick	0.60	0.49	0.105	0.398	0.45	0.74	0.67	0.32	0.149	0.048
bite	0.54	0.08	0.078	0.001	0.67	0.41	0.14	0.03	0.110	0.479
threat	5.88	2.71	0.619	0.001	6.23	5.53	3.21	2.21	0.875	0.543
butt	3.42	1.83	0.563	0.050	3.35	3.50	2.47	1.18	0.797	0.179
agonistic total	10.55	5.17	1.290	0.004	10.79	10.30	6.58	3.77	1.824	0.191
Milking period										
positive	0.03	0.06	0.033	0.394	0.00	0.05	0.08	0.04	0.042	0.210
clash	0.10	0.09	0.033	0.817	0.11	0.08	0.10	0.08	0.043	0.930
kick	0.37	0.44	0.121	0.891	0.49	0.26	0.51	0.37	0.170	0.605
bite	0.13	0.04	0.040	0.123	0.19	0.07	0.06	0.02	0.056	0.466
threat	2.97	1.62	0.352	0.002	3.86	2.08	1.81	1.43	0.497	0.127
butt	2.26	1.44	0.267	0.019	2.98	1.54	1.69	1.20	0.378	0.158
agonistic total	5.86	3.70	0.753	0.004	7.67	4.05	4.23	3.17	1.065	0.109

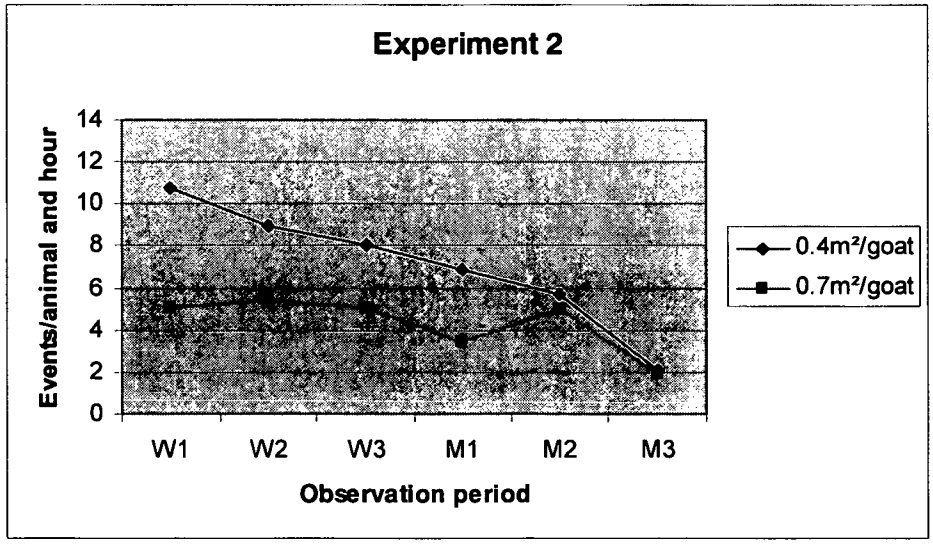


Figure8: FREQUENCY OF 'AGONISTIC TOTAL' (INTERACTIONS PER ANIMAL AND HOUR) IN EXPERIMENT 2 DURING DIFFERENT TREATMENTS (0.4/0.7m²/GOAT) IN THE TIME COURSE OF THE OBSERVATIONS (W1, W2, W3: 5 min PERIODS DURING THE WAITING PERIOD; M1, M2, M3: PHASES DURING MILKING)

In experiment 2 the frequency of all agonistic interactions taking place differed between the two different types of treatments (Figure8). The tendency for agonistic behaviour to decline during the observation period was found in both treatments. At the beginning twice as much agonistic behaviour was found, if 0.4 (W1: 11 interactions/animal and hour) compared to 0.7m²/goat (W1: 5 interactions/animal and hour) was available. Frequencies found at the end of the observation period however were almost the same (M3/0.4m²: 2 interactions/animal and hour, M3/0.7m²: 1.9 interactions/animal and hour).

5.1.3. Experiment 3

In this experiment, only two behavioural classes were significantly affected by the treatment (long/square shaped collecting area) and the interaction between treatment and milking time (Table14).

During the waiting period goats in a square shaped collecting area were clashing more often than those in long and narrow shaped areas (0.04/0.2 interactions/animal and hour). LS-means for kicking, threatening and agonistic behaviour in general as well as socio-positive interactions were also found to be slightly, but not significantly higher in square shaped collecting areas (Table14). An increase was also found when goats were milked in the evening e.g. long shaped area 'threat' 5/4 interactions/animal and hour. The changes in socio-positive behaviour were minor.

Kicking behaviour was significantly affected by treatment*milking time during the milking period. When goats were milked in the morning a square shape resulted in higher levels of kicking (0.5/0.2 interactions/animal and hour). Yet evening milkings combined with long and narrow shaped areas caused more kicking among goats (0.4/0.2 interactions/animal and hour). Regarding socio-positive behaviour no clear pattern was found (Table14).

LS-means calculated for almost all behavioural groups were about 50% higher for the waiting period than those during the milking period (Table14).

Table14: EXPERIMENT 3 - LEAST SQUARE-MEANS (LS-MEANS), STANDARD ERRORS (SE) AND P-VALUES (p) ARE GIVEN FOR ALL BEHAVIOURAL GROUPS FOR THE WAITING PERIOD (W) AND MILKING PERIOD (M). LS-MEANS REFER TO TREATMENT (LONG/SQUARE) AND TREATMENT*MILKING TIME (e-EVENING, m-MORNING) AND ARE GIVEN IN INTERACTION PER ANIMAL AND HOUR.

Behaviour	**Treatment**				**Treatment*milking time**					
Waiting period	**long**	**square**	**SE**	**p**	**long e**	**long m**	**square e**	**square m**	**SE**	**p**
positive	0.00	0.15	0.021	0.135	0.10	0.10	0.13	0.16	0.029	0.609
clash	0.04	0.23	0.026	< 0001	0.03	0.05	0.29	0.17	0.036	0.064
kick	0.51	0.55	0.131	0.717	0.55	0.47	0.67	0.44	0.170	0.738
bite	0.28	0.27	0.073	0.942	0.30	0.26	0.12	0.42	0.103	0.107
threat	4.29	4.88	0.644	0.371	4.70	3.88	5.56	4.20	0.863	0.635
butt	3.13	2.83	0.691	0.668	3.15	3.11	2.94	2.73	0.829	0.868
agonistic total	8.24	8.78	1.446	0.564	8.73	7.76	9.59	7.97	1.822	0.815

Milking period										
positive	0.04	0.05	0.057	0.874	0.00	0.09	0.10	0.01	0.073	0.190
clash	0.08	0.05	0.043	0.441	0.08	0.09	0.01	0.09	0.053	0.414
kick	0.30	0.35	0.098	0.576	0.35	0.24	0.20	0.51	0.125	0.069
bite	0.09	0.05	0.026	0.245	0.09	0.09	0.01	0.09	0.036	0.287
threat	1.91	2.05	0.338	0.593	2.00	1.81	2.23	1.86	0.441	0.949
butt	1.88	1.72	0.294	0.970	1.52	2.23	1.65	1.80	0.378	0.445
agonistic total	4.26	4.24	0.781	0.743	4.05	4.47	4.13	4.35	0.974	0.988

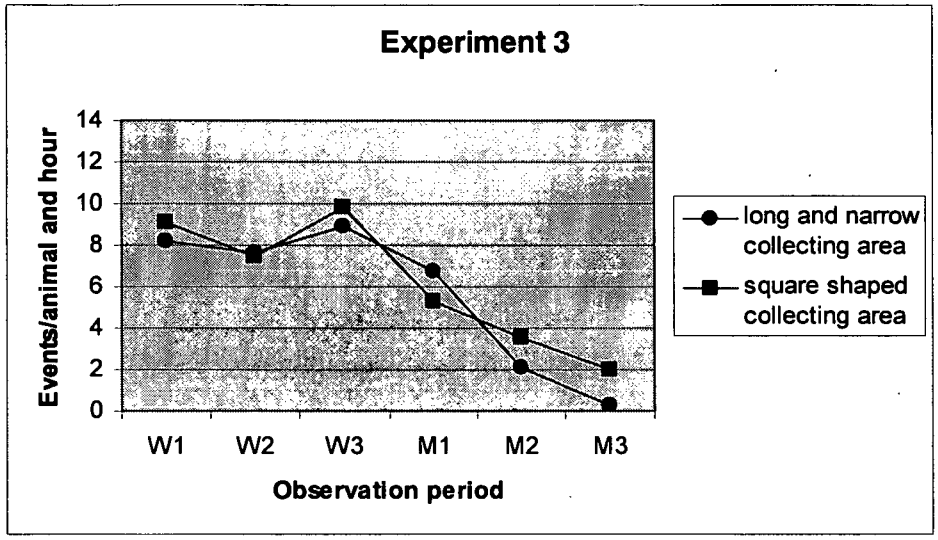


Figure9: FREQUENCY OF 'AGONISTIC TOTAL' (INTERACTIONS PER ANIMAL AND HOUR) IN EXPERIMENT 3 DURING DIFFERENT TREATMENTS (LONG/SQUARE) IN THE TIME COURSE OF THE OBSERVATIONS (W1, W2, W3: 5 min PERIODS DURING THE WAITING PERIOD; M1, M2, M3: PHASES DURING MILKING)

Different shapes of the collecting area providing 0.4m²/ goat did not clearly affect the frequency of total agonistic interactions in the course of the waiting and milking period (Figure9).

5.2. Injuries

The frequency of fresh injuries in both groups and their respective experiments is shown Figure10. A total of eleven animals with fresh injuries were found during the experimental period of six weeks. Up to four animals were diagnosed with fresh lesions per experiment and group. In most cases only one injured animal was found. In group 1 fresh injuries occurred in almost all experiments except in experiment 1, when more space per animal was available. In group 2 however fresh injuries were only recorded twice throughout the

experimental period. These injuries occurred in experiment 1 and 2 when the collecting area was reduced to 0.4m²/animal.

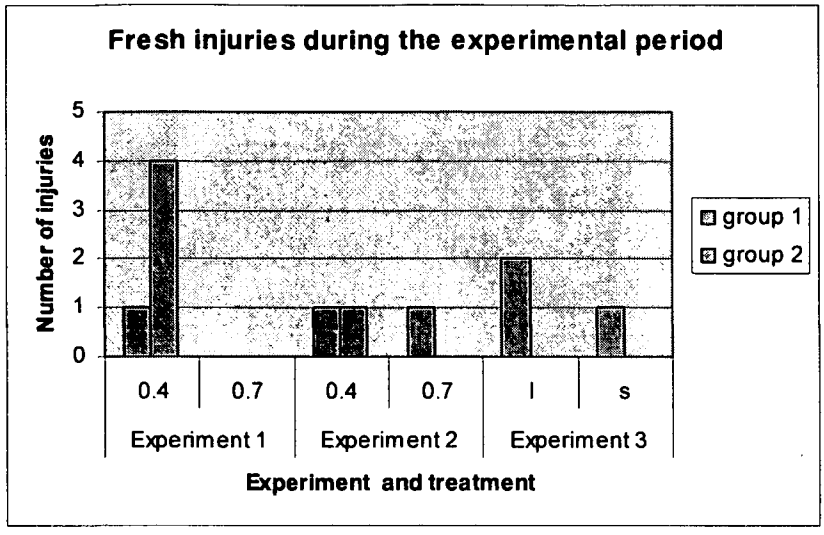
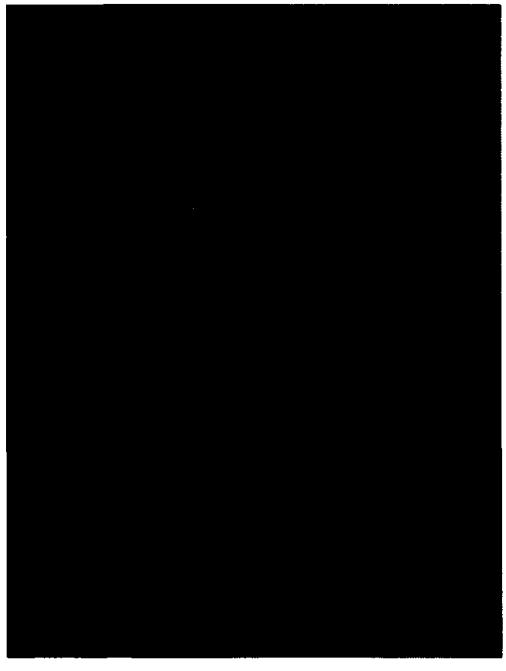
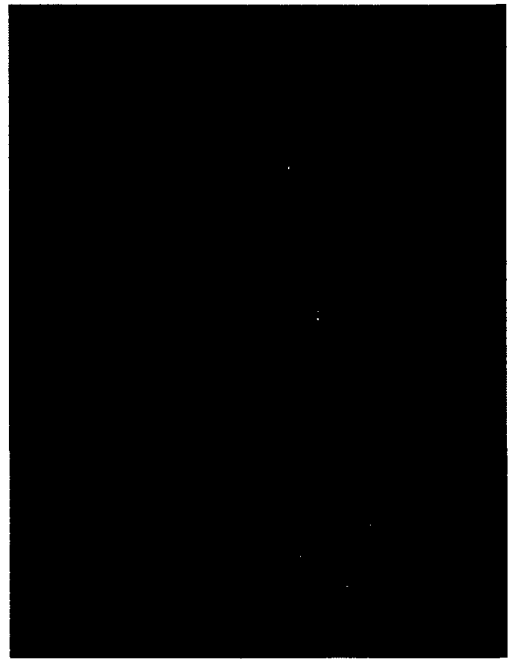
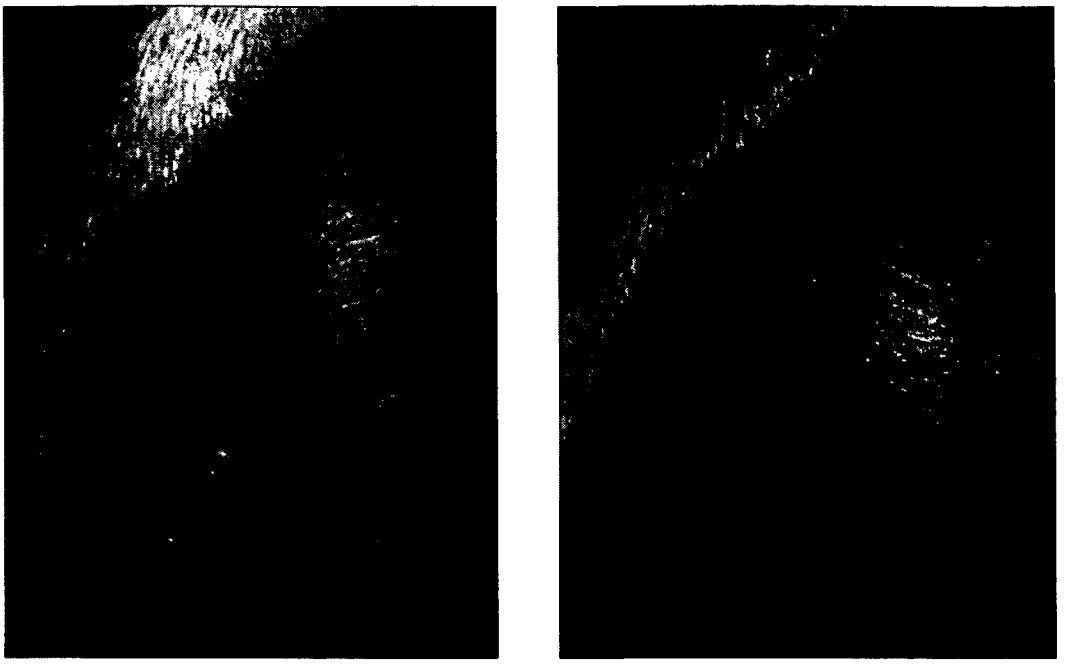


Figure10: FREQUENCY OF FRESH INJURIES IN GROUP ONE AND TWO FOR THE RESPECTIVE EXPERIMENTS AND TREATMENTS TROUGHOUT THE EXPERIMENTAL PERIOD.

The types of fresh injuries documented throughout the experiment are recorded in Picture1 to 4.







Picture1 TO 4: FRESH INJURIES AT THE EXTREMITIES AND UDDER. THE SCRATCH ON THE UDDER ON THE BOTTOM LEFT PICTURE (NR.3) IS ALREADY HEALING.

6. Discussion

As expected, reducing the size of the collecting area resulted in more agonistic and less socio–positive behaviour. With regard to total agonistic behaviour, interactions increased 1.5 to 6 fold in experiment 1 and 2 when 0.4m²/goat was allowed compared to 0.7m²/animal. More prevalent behaviours such as threatening, butting and overall agonistic behaviour increased 1.5 to 2 fold. Although on a rather low level, clashing and biting interactions were found to increase 4.5 to 6 fold with reduced space allowance in the collecting area.

Literature on this subject is scarce and to my knowledge no directly comparable data is available. Andersen and Bøe (2006) however conducted an experimental study with different stocking rates of goats in the lying area. In this study, a reduction of lying space did not influence social interactions significantly. A different organisation of lying space (one versus two levels) however did influence social interactions significantly. When goats had the opportunity to rest on two levels less aggressive behaviour such as displacements were observed. Regarding feeding space, an increase in number of goats per feeding place was found to lead to more aggressive interactions and displacements (Jørgensen et al. 2006). In some species such as cattle a 'crowding effect' has been reported. This can be seen if stocking rates are high resulting in reduced interaction frequencies. This could also be expected during the waiting period, but did not take place in this study. In fact, Tölü (2005) reported that biting among goats increases, when individual distance is reduced. Furthermore it has been shown that narrow areas cause an increased biting frequency (Tölü and Savaş 2007) as it was also observed in this study. During the waiting period in experiment 2, which provided a long and narrow shaped collecting area, biting was influenced significantly (LS-means given in interaction per animal and hour 0.54 – 0.4m² and 0.08 – 0.7m²/goat).

Behaviour among goats in the collecting area also differed after the milking had started. When the animals were waiting the level of threatening, butting and total agonistic behaviour was up to 2.7 times higher than during the milking period, irrespective of space allowance. During the waiting period the frequency of agonistic behaviours declined in both treatments (0.4m²and 0.7m²/goat) and experiments (1 and 2). Goats continued to perform less agonistic behaviour during the milking period. Though the frequency of agonistic behaviour was steadily changing until the end of the milking.

The lower frequency of agonistic behaviour during the milking period might be due to more space allowance per animal, according to Jørgensen et al. (2006) and Tölü (2005). Dominant animals being first in the milking order and therefore leaving the collecting area at the beginning of the milking period might also be the reason for less agonistic interactions once the milking started. The assumption that a certain amount of space e.g. towards the end of the milking period, allowing to maintain individual distances and avoiding other animals, would result in agonistic behaviour to be reduced completely, was not confirmed. A significant effect of the interaction between treatment and milking time on kicking behaviour in experiment 2 and 3 may indicate additional relevant influences, rather than space, on agonistic behaviour. One of these influences might be due to dominant animals. Some of them might not go into the milking parlour with the first lot and carry on chasing subordinates more or less frequently and therefore keeping the agonistic behaviour at a certain level. This was observed quite often towards the end of the milking period during this experimental study. The rank of the active animals however is not known. A change in frequency of agonistic behaviour could also be due to animals crowding in a certain area, e.g. around the entrance door to the milking parlour trying to leave the collecting area as soon as possible, and therefore not spreading evenly in the collecting area. Frustration among goats, due to waiting for 15 minutes before the milking started, which is released during the milking period might also prevent agonistic behaviour to level off. The fact that these goats spent most of their time on the pasture might also influence their behaviour in the collecting area. On

pasture social distances can be maintained and other goats avoided, which could lead to even more interactions when the groups go into the collecting area, allowing only a fraction of space they had before. On the other hand goats might interact less in the collecting area, due to their chance to keep social distances and avoid each other during the rest of the day. Goats kept inside all year might behave differently, as they hardly have the opportunity to avoid other animals if they want to. In this case goats might interact even more agonistically in the collecting area. During the experimental period the goats had to stay inside for some days due to bad weather. During the milkings on these days the goats seemed to be very unsettled and interacting more aggressively than usual.

With regard to socio–positive behaviour a significant influence of treatment (0.4m²and 0.7m²/goat) was only found once during the waiting period of experiment 2. Positive interactions however accounted for less than 1% of all interactions, which should be considered when relevance and importance of this behavioural class are taken into account.

The behavioural pattern of the animals was similar in experiment 1 and 2, even though different basic shapes were used to test the influence of space allowance. This might be due to space being a more determinant factor for social behaviour than e.g. shape.

Results for experiment 3, testing the influence of shape, provide a similar picture. More agonistic interactions had been expected in long and narrow areas and more socio–positive interactions in square shaped areas. Shape affected clashing and kicking, but both of them were recorded very rarely and no clear influence of shape could be identified.

In square shaped collecting areas a slightly higher mean frequency of agonistic behaviour (3.6 interactions/ animal and hour) was found, compared to long and narrow ones (3.0 interactions/ animal and hour).

Literature on this particular subject is also scarce. Tölü and Savaş (2007) state that the highest rates of butting in a goat farming system occur on pasture, irrespective of shape and size. The results of the present study confirm (experiment 3) and contradict (experiment 1 and 2) Tölü and Savaş (2007). If the results of experiment 1 and 2 are contrasted it can be seen that more behavioural groups were affected by treatment (0.4m² and 0.7m²/goat) in experiment 2, e.g. socio-positive, clashing, kicking and biting behaviour. All these interactions were carried out less than once per animal and hour. The fact that more behavioural groups were affected might be due to long and narrow shapes, as provided in experiment 2, having more impact on agonistic interactions than wider, more square shaped areas. The shapes provided in experiment 3 might have hardly affected social behaviour significantly due to being too similar. Different results might be obtained, if the differences are clearer.

The lower interaction frequency in experiment 3 might be due to goats adapting to different shaped collecting areas and therefore interacting less in the final experiment. It could also be due to lack of space to express behaviour, as both treatments offered 0.4m²/goat. In case of them just tolerating the treatment and therefore not interacting much, compared to the previous experiments, an increase during the milking period could be expected. Thus the frequency of agonistic behaviour declined steadily towards the end of the milking period. In this case the frequency of agonistic behaviour was also believed to balance off at some point during the milking, but was steadily declining until the end of the milking. The behavioural pattern during the milking period might be explained by similar reasons than already mentioned previously in experiment 1 and 2.

As in experiment 1 and 2 socio–positive behaviour accounted for less than 1% of all interactions. This type of social behaviour was not significantly affected by shape in experiment 3.

With regard to injuries, an influence of size and shape was observed. On seven out of sixty six goats 'fresh injuries' were recorded when 0.4m² were allowed per animal, whereas in

larger collecting areas it was only one animal. If different shapes were provided two animals were freshly injured when the collecting area was long and narrow while one was documented when a square shaped collecting area was offered. The low level of injuries does not allow a statement towards the influence of space allowance and shape. This might be due to the fact that this study focussed on social behaviour and the observation period for injury documentation was too short. Furthermore injuries were only documented once per week, therefore some injuries might have healed before being documented. A different ratio of horned and naturally polled/disbudded goats might also bring different results. In statistical analysis the presence of horns was not taken into account. Descriptive analysis shows that horned goats interacted five times more often than polled ones. Thus animals affected by injuries are found to be mostly horned ones (ten out of eleven).

7. Conclusions

Agonistic behaviour in goats in the collecting area is mainly influenced by space allowance. Levels of agonistic behaviours increased 1.5 to 6 times fold, if 0.4m²/goat was allowed compared to 0.7m²/per goat. Socio–positive interactions occurred very rarely in this area. The effects of shape on social behaviour were minor and therefore the most efficient way to decrease agonistic interactions is to provide more space in collecting areas. Yet it should be taken into account that agonistic behaviour in the collecting area might also be affected by other factors than space allowance. To give more detailed information on risk and occurrence of injuries further investigations are necessary.

8. Summary

In this Master thesis the influence of space allowance and shape of the collecting area on social behaviour and injuries was tested. As confined areas might be critical especially for horned animals, this study has been carried out. Disbudding of dairy goats has been controversely discussed in Austria in recent years. For the time being, disbudding is allowed under defined circumstances until 2010.

A herd of sixty-six goats, mostly horned (breed Bunte Deutsche Edelziege) was randomly assigned to two groups. Three experiments took place during a period of six weeks. In each experiment, treatments were applied for one week with cross-over taking place after the first week. In experiment 1 and 2 the influence of space allowance in experiment 3 the effect of shape was tested. Agonistic and socio-positive behaviour was observed by continuous behaviour sampling during morning and evening milkings on five days of the week. The scoring of injuries took place at the beginning and end of every week, when all visible injuries were recorded. Behavioural data were pooled into classes (agonistic total, threat, butt, clash, kick, bite, positive) and all experiments analyzed separately using linear mixed model analysis. Data on injuries were only analyzed descriptively.

A significant influence of space allowance was found on most behavioural classes. Goats interacted more, when less space was provided. Shape did only affect two classes significantly, both of them occuring less than once per animal and hour. Yet no clear influence of shape could be identified. Injuries were affected by space allowance and shape.. The level of injuries however was to low to make a statement regarding space allowance and shape.

The effects of shape on social behaviour were minor and therefore the most efficient way to reduce agonistic interactions is to provide more space in the collecting area. To give more detailled information on risk and occurence of injuries further investigation will be needed.

9. Zusammenfassung

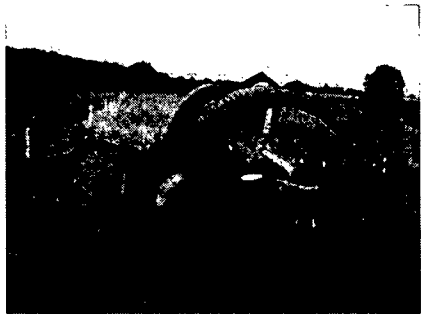
In dieser Diplomarbeit wird der Einfluss von Platzangebot und Form des Wartebereichs auf Sozialverhalten und Verletzungen untersucht. Da beengte Bereiche, wie z.B. der Wartebereich, für behornte Tiere im Bezug auf Verletzungen als kritisch gesehen werden können wurde diese Studie veranlasst. In den letzten Jahren wurde in Österreich über die Enthornung von Milchziegen diskutiert und ist vorerst unter bestimmten Umständen bis 2010 erlaubt.

Für den Versuch wurde eine großteils behornte Herde von 66 Bunten Deutschen Edelziegen zufällig in zwei Gruppen geteilt. Über einen Zeitraum von sechs Wochen wurden drei Experimente an diesen Tieren angewendet. Jedes Experiment wurde zwei Wochen getestet, wobei nach der ersten Woche die Gruppen getauscht wurden. Im Experiment 1 und 2 wurde der Einfluss von Platzangebot, im Experiment 3 von Form untersucht. Agonistisches und sozio-positives Verhalten wurde mit Hilfe von Direktbeobachtung während des Morgen- und Abendmelkens an 5 Wochentagen erhoben. Am Beginn und Ende jeder Woche wurden alle sichtbaren Verletzungen erhoben. Die Daten der Verhaltensbeobachtung wurden in Gruppen eingeteilt (agonistisch total, drohen, Kopfstoß, Frontalstoß, hebeln, beißen und positiv) und nach Experimenten getrennt mit Hilfe eines gemischten linearen Modells analysiert. Die Auswertung der Verletzungen erfolgte deskriptiv.

Bei fast allen Verhaltensgruppen wurde ein signifikanter Einfluss des Platzangebotes festgestellt, wobei ein geringeres Platzangebot mehr Interaktionen zur Folge hatte. Die Form des Wartebereiches beeinflusste hingegen nur zwei selten auftretende Verhaltensweisen signifikant. Das Auftreten von Verletzungen war von Platzangebot und Form abhängig. Da das Verletzungsniveau jedoch so gering war, ist es nicht möglich eine Aussage über diese beiden Einflussfaktoren zu treffen.

Da die Form das Sozialverhalten kaum signifikant beeinflusst hat, kann agonistisches Verhalten im Wartebereich vor allem durch größeres Platzangebot reduziert werden. Um genauere Aussagen über Verletzungsrisiko bzw. –vorkommen zu treffen sind weitere Untersuchungen erforderlich.

10. Acknowledgements



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11. References

Addison, W. E. and Baker, E., 1982: Agonistic behavior and social organization in a herd of goats as affected by the introduction of non – members, Applied Animal Ethology 8, 527 -535

Alvarez, L., Zarco, L., Galino, F., Blache, D., and Martin, G.B., 2007: Social rank and response to the 'male effect' in the Australian Cashmere goat, Applied Reproduction Science 102, 285-266

Andersen, .I.L. and Bøe, K.E., 2006: Resting pattern and social interactions in goats -The impact of size and organisation of lying space, Applied Animal Behaviour Science, In Press, Corrected Proof

Aschwanden, J., Gygax, L., Wechsler, B. and Keil, N. M., 2007: Welchen Einfluß haben die Qualität sozialer Bindungen, der Rangunterschied, das Gruppierungsalter und die Behornung auf soziale Distanz zwischen zwei fressenden Ziegen?, Aktuelle Arbeiten zur artgemäßen Tierhaltung 2007, KTBL-Schrift 461, Kuratorium für Technik und Bauwesen in der Landwirtschaft e. V., Darmstadt

Barroso, F.G., Alados, C.L. and Boza, J., 2000: Social hierarchy in the domestic goat: effect on food habits and production, Applied Animal Behaviour Science 69, 35-53

Boe, K.E., Andersen, I.L., Buisson, L., Simensen, E. and Jeksrud, W.K., 2007: Flooring preferences in dairy goats at moderate and low ambient temperature, Applied Animal Behaviour Science, In press

Buchenauer, D., Hinrichsen, J. K., and Soumare, A., 1984: Behaviour of grazing goats, KTBL-Schrift 363-366, Kuratorium für Technik und Bauwesen in der Landwirtschaft e. V., Darmstadt

Bürger, M., 1966: Das Wiederkauen, eine vergleichende ethologische Untersuchung an Haus- und Wildtieren in zoologischen Gärten. Archiv Tierernährung 16, 472-505 cited in Krehl, A., 1998: Ethologische Bewertung der Getrennt- und Gemischtbeweidung von Magerrasen mit Schafen und Ziegen, Internationale Nutztierzucht und –haltung, Mitteilungsblatt Nr. 20, Universität Kassel

Collis, K. A., 1976: An investigation of factors related to the dominance order of a herd of dairy cows of similar age and breed, Applied Animal Ethology 2, 167 – 173

Coté, S. and Festa – Bianchet, M., 2001: Reproductive success in female mountain goats: the influence of age and social rank, Animal Behaviour 62, 173-181

Fernández, M.A., Alvarez, L. and Zarco, L., 2007: Regrouping in lactating goats increases aggression and decreases milk production, Small Ruminant Research 70, 228-232

Fischer, T., 1990: Zum Verhalten der Hausziege, Diplomarbeit, Universität Kassel

Fournier, F. and Festa-Bianchet, M., 1995: Social dominance in adult female mountain goats, Animal Behaviour 49, 1449-1459

Grauvogel, A., 1974: Verhaltensbedingte Anforderungen der Tiere in Comberg, G. und Hinrichsen, J. K., 1974: Tierhaltungslehre, Verlag Eugen Ulmer

Immelmann, K., 1982: Wörterbuch der Verhaltensforschung, Parey Verlag, Berlin

Jørgensen, G.H.M., Andersen, I.L. and Bøe, K.E., 2006: Feed intake and social interactions in dairy goats - The effects of feeding space and type of roughage, Applied Animal Behaviour Science, In press

Keil, N. M., 1995: Untersuchungen zum Sozialverhalten von Milchziegen in großen Gruppen, Diplomarbeit, Technische Universität München

Krehl, A., 1998: Ethologische Bewertung der Getrennt- und Gemischtbeweidung von Magerrasen mit Schafen und Ziegen, Internationale Nutztierzucht und –haltung, Mitteilungsblatt Nr. 20, Universität Kassel

Loretz, C., 2003: Untersuchungen zum Verhalten von behornten und hornlosen Ziegen im Laufstall am Fressplatz und im Liegebereich, Dissertation, Veterinärmedizinische Fakultät Zürich

Mc Cammon - Feldmann, B., Van Soest P. J., Horvath, P. and Mc Dowall, R. E., 1981: Cornell International Agriculture Mimeograph 88, cited in Krehl, A., 1998: Ethologische Bewertung der Getrennt- und Gemischtbeweidung von Magerrasen mit Schafen und Ziegen, Internationale Nutztierzucht und –haltung, Mitteilungsblatt Nr. 20, Universität Kassel

Mowlem, A., 1988: Goat farming, Farming Press Books, United Kingdom, 1. Edition

Müller, S., 2006: Einflussfaktoren auf den Ablauf von sozialen Interaktionen bei Milchziegen, Diplomarbeit, Eidgenössische Technische Hochschule Zürich

Österreichischer Bundesverband für Schafe und Ziegen, 2007: Persönliche Mitteilung, unveröffentlicht

Rowell, T. E., 1974: The concept of social dominance, Behavioural Biology 11, 131 – 154

Sambraus, H. H., 1978: Nutztierethologie, Das Verhalten landwirtschaftlicher Nutztiere - Eine angewandte Verhaltenskunde für die Praxis, Verlag Paul Parey, Berlin Hamburg,1. Auflage

Schaller, G. B. and Laurie, A., 1973: Courtship of the wild goat, Zeitschrift für Säugetierkunde 39, 115 - 127

Shank, C.C., 1972: Some aspects of social behaviour in a population of feral goats (Capra hircus L.), Zeitschrift für Tierpsychologie 30, 488-528

Simantke, C., Hörning, B. and Ubbelohde, J., 1994: Chancen einer umwelt- und artgerechten Ziegenhaltung im Odenwald unter Berücksichtigung der Markterfordernisse. Beratung Artgerechte Tierhaltung, Witzenhausen cited in Krehl, A., 1998: Ethologische Bewertung der Getrennt- und Gemischtbeweidung von Magerrasen mit Schafen und Ziegen, Internationale Nutztierzucht und –haltung, Mitteilungsblatt Nr. 20, Universität Kassel

Tölü, C., 2005: Studies on social hierarchy and agonistic behaviours in goats, master thesis, Canakkale Onsekiz Mart University, Turkey cited in Tölü, C. and Savas, T., 2007: A brief report on intra-species aggressive biting in a goat herd, Applied Animal Behaviour Science 102, 124-129

Tölü, C. and Savas, T., 2007: A brief report on intra-species aggressive biting in a goat herd, Applied Animal Behaviour Science 102, 124-129

Verordnung der Bundesministerin für Gesundheit und Frauen über die Mindestanforderungen für die Haltung von Pferden und Pferdeartigen, Schweinen. Rindern, Schafen, Ziegen, Schalenwild, Lamas, Kaninchen, Hausgeflügel, Straußen und Nutzfischen - 1. Tierhaltungsverordnung (in der Fassung vonm 01.01.2005), BGBl. II Nr. 485/2004

Verordnung der Bundesministerin für Gesundheit und Frauen über die Mindestanforderungen für die Haltung von Pferden und Pferdeartigen, Schweinen. Rindern, Schafen, Ziegen, Schalenwild, Lamas, Kaninchen, Hausgeflügel, Straußen und Nutzfischen - Änderung der 1. Tierhaltungsverordnung, BGBl. II Nr. 530/2006

VIS Jahreserhebung, 2006: Ziegenbestand in Österreich, herausgegeben vom Österreichischer Bundesverband für Schafe und Ziegen, unveröffentlicht

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Table13: EXPERIMENT 2 - LEAST SQUARE-MEANS (LS-MEANS), STANDARD ERRORS (SE) AND P-VALUES (p) ARE GIVEN FOR ALL BEHAVIOURAL GROUPS FOR THE WAITING PERIOD AND MILKING PERIOD. LS-MEANS REFER TO TREATMENT (0.4/0.7m² PER GOAT) AND TREATMENT*MILKING TIME (e-EVENING, m-MORNING) AND ARE GIVEN IN INTERACTION PER ANIMAL AND HOUR..... 26

Table14: EXPERIMENT 3 - LEAST SQUARE-MEANS (LS-MEANS), STANDARD ERRORS (SE) AND P-VALUES (p) ARE GIVEN FOR ALL BEHAVIOURAL GROUPS FOR THE WAITING PERIOD (W) AND MILKING PERIOD (M). LS-MEANS REFER TO TREATMENT (LONG/SQUARE) AND TREATMENT*MILKING TIME (e-EVENING, m-MORNING) AND ARE GIVEN IN INTERACTION PER ANIMAL AND HOUR..... 27