A comparison of group housing and individual housing for dairy bulls kept for breeding

En jämförelse av grupphållning och individuell hållning av avelstjurar

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Photo: Isabel Dahlgren

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1. SUMMARY

This study was conducted at VikingGenetics' bull breeding station in Falkenberg, Sweden. The bulls waiting for the results of their progeny testing at this station are either kept in group housing or individual housing. Since both of these housing systems have advantages and disadvantages, it was in the interest of VikingGenetics to know which of these housing systems is the best. The aim of this study was to investigate the welfare of the bulls in these two housing systems through behavioural observations and the use of activity monitors. In the preparations for the study 16 bulls, 8 in each housing system, were chosen. These bulls were from 34-60 months of age and of the breeds Swedish Holstein and Swedish Red.

The behaviour of the bulls was recorded using focal animal sampling with instantaneous recording at three minute intervals of general behaviours and continuous recording of social and abnormal behaviours. Each bull was observed one hour per week during three weeks. Activity monitors (IceTags 2.004, IceRobotics) were placed on each bulls hind leg and were left there during the whole behavioural observation period. The behavioural data and activity data were analyzed using Wilcoxon rank sum test. The results showed a significantly higher level of activity and number of steps per 24 hours in the group housed bulls. There were no significant differences in the general behaviours, or social and abnormal behaviours performed, except for the behaviour "pushing", which was significantly more performed in group housing than individual housing. "Pushing" is when one animal places its cheek against another individual and pushes. Few aggressive interactions and no abnormal behaviours were recorded during the study.

Since the reason for the higher activity level in group housing is unknown. It is, from this, difficult to draw conclusions about the welfare of the bulls in the two housing systems. The higher activity in group housing could indicate that the bulls can get outlet for their motivation to be locomotive. However, it could also be a result of the animals moving around to avoid other individuals.

The individual pens were equipped with social gates, through which the bulls could place their heads and necks. These enabled the individually housed bulls to have social interactions, although limited. One advantage with individual housing is that it is more difficult for the bulls to injure each other, while some of the disadvantages are the restriction in social interactions and the smaller area to move around upon. Some of the advantages with group housing are that the bulls can have more social interactions and the total area is larger. Some disadvantages with group housing are the higher risk of injuries and that subordinates might be chased or displaced from resources.

Hence, answering the question of which housing system is the best is not a simple task and the advantages and disadvantages must be weighted against each other.

2. SAMMANFATTNING

Denna studie utfördes på VikingGenetics tjurstation för avelstjurar i Torsholm, Falkenberg. De tjurar som väntar på avelsvärden hålls antingen i gruppinhysning eller individuell inhysning, och eftersom det finns både för- och nackdelar med båda inhysningssystemen var VikingGenetics intresserade av att få veta vilket inhysningssystem som är bäst. Syftet med denna studie var därför att undersöka vilket av dessa två inhysningssystem som är bäst för tjurarnas välfärd. Detta gjordes med hjälp av beteendeobservationer och aktivitetsmätare. Inför studien valdes 16 tjurar, 8 i varje inhysningssystem, ut. Dessa tjurar var från 34-60 månaders ålder och av raserna Holstein och SRB.

Tjurarnas beteende registrerades med hjälp av fokaldjursobservationer med momentanregistrering var tredje minut för generella beteenden och kontinuerlig registrering för sociala och onormala beteenden. Varje tjur observerades en timme per vecka under tre veckor. Aktivitetsmätare (IceTags 2.004, IceRobotics) placerades på varje tjurs bakben och lämnades där under hela perioden då beteendeobservationer utfördes. Data från beteendeobservationerna och aktivitetsmätarna analyserades sedan med Wilcoxons rangsummetest. Resultaten visade att tjurarna i gruppinhysningen hade en högre aktivitetsnivå och tog fler steg per dygn än de individuellt inhysta tjurarna. Det fanns däremot ingen signifikant skillnad mellan inhysningssystemen vad gällde generella beteenden och sociala och onormala beteenden, förutom ”pushing”, som var mer vanligt förekommande i gruppinhysning. ”Pushing” är när en tjur lägger kinden mot en annan tjur och trycker. Få aggressiva interaktioner och inga onormala beteenden registrerades under studien.

Eftersom anledningen bakom den högre aktivitetsnivån hos de gruppinhysta tjurarna är okänd, är det svårt att dra slutsatser om tjurarnas välfärd i de två systemen utifrån dessa resultat. Den högre aktivitetsnivån i gruppinhysningen skulle kunna indikera att dessa tjurar får utlopp för sitt rörelsebehov. Det skulle däremot även kunna vara ett resultat av att tjurarna rör sig i syfte att undvika andra tjurar i gruppen.

Boxarna i den individuella inhysningen var utrustade med sociala grindar, genom vilka tjurarna kunde sträcka in huvud och hals. Dessa grindar möjliggjorde viss social kontakt med andra tjurar. En fördel med individuell inhysning är att det är svårare för tjurarna att skada varandra. Några nackdelar med samma inhysning är att deras möjlighet till sociala interaktioner är begränsad och att ytan att röra sig på är mindre i de individuella boxarna. Några fördelar med gruppinhysning är att tjurarna kan ha mer sociala interaktioner och att de har större yta att röra sig på. Några nackdelar med gruppinhysning är att risken för skador är större och att ett djur som är lågt i rang kan bli jagat och få dålig tillgång till resurserna. Detta visar att det inte finns något enkelt svar på frågan om vilket inhysningssystem som är bäst för tjurarnas välfärd, utan fördelarna och nackdelarna måste vägas mot varandra.

3. INTRODUCTION

3.1. Background

For future reconstruction of the stables for bulls waiting for results of their progeny testing, it is in the interest of VikingGenetics to know the advantages and disadvantages of individual housing and group housing pens, for these bulls.

Both systems have advantages and disadvantages regarding animal welfare. One advantage with group housing pens is that they allow the bulls to express their social behaviours. However, a disadvantage is that some of the bulls fight and injure each other. The individual pens are safer regarding injuries since it is more difficult for the bulls to hurt each other, but on the other hand, these pens restrict the bulls' possibilities of social interactions.
According to Absmanner et al. (2009) animal behaviour can be a helpful indicator when assessing the welfare of animals.

One definition of natural behaviour described by Lidfors et al. (2005) is that it is the range of diverse behaviours expressed by animals kept in environments which allow them to perform behaviours formed in the process of evolution. In the same article it is also said that some important features of natural behaviour are innate behaviours and motivation, and that stress and abnormal behaviours can be the consequence of disruption of those features of natural behaviour.

Cattle are kept in a great variety of housing systems all over the world (Bouissou et al., 2001). Even though domestication may have modified the characteristics of some animal behaviours, it is argued that the fundamental social features of the domesticated animals are still similar to those of conspecifics in the wild (Price, 1984). However, the ancestral wild species of cattle (*Bos primigenius)* became extinct in 1627, but observations of social structure and behaviour of feral cattle can bring comprehension of the natural behaviours and social structure of the ancestral species (Bouissou et al., 2001).

3.1.1. Group living

Cattle are highly social animals, living in organised groups with stable relationships within the group (Bouissou and Boissy, 2005; Watts and Stookey, 2000). Such relationships can include social grazing and social grooming and can, even for unrelated animals, stay stable for years (Reinhardt and Reinhardt, 1981). Male cattle of three to four years can, when outside of the mating period, be either solitary or live in groups of up to ten bulls (Bouissou et al., 2001). However, these male groups are less solid than groups of females (Bouissou et al., 2001). According to Hall (1986) males of more than four years in the Chillingham herd in northern England lived in male groups consisting of two to three animals, while young bulls, cows and heifers lived in mixed groups.

Cooperation between individuals is necessary to facilitate group living, which can be both beneficial and disadvantageous for an individual (Mendl and Held, 2001). As stated by Mendl and Held (2001) a clear disadvantage of group living is the sharing of resources with other individuals of the group. On the other hand, in the wild, group living can be beneficial through enhanced predator detection and defence (Mendl and Held, 2001). Another benefit of group living is the group's ability to lower an individual's arousal during a stressful event (Bouissou et al., 2001).

3.1.2. Behaviours

According to a study by Colenbrander et al. (1991) the feeding behaviour of cattle can vary with different housing systems. This was shown in a study by Albright (1993) where cows fed in groups had a tendency to eat more than when fed individually. This is an effect of social facilitation where one animal can be stimulated to eat by watching another individual performing this behaviour (Curtis and Houpt, 1983).

Locomotion is an important behaviour, which cattle have an innate motivation to perform (Albright and Arave, 1997). They move to find food and water, to play, seek shelter, give birth and to keep distances to dominant individuals (Albright and Arave, 1997). Cattle are crepuscular animals, which means that their most active times are at dawn and dusk (Albright, 1993).

Cattle communicate through visual, vocal, olfactory and tactile communication (Albright and Arave, 1997; Bouissou et al., 2001). Visual communication is important in cattle (Albright and Arave, 1997; Bouissou et al., 2001). An example of a visual signal of the bull is the threat display which usually commences with a broadside view with an arched back and the head down. It can be followed by shaking movements of the head and pawing and horning of the ground (Albright and Arave, 1997).

Vocalisations in cattle provide conspecifics with information concerning the caller such as age, dominance status and sex (Watts and Stookey, 2000). Vocalisations may also indicate motivations, intentions and the psychological and physiological state of the caller (Watts and Stookey, 2000). However, Watts and Stookey (2000) state that the understanding of vocalisations in cattle is poor. It is, however, probable that the vocalisations of cattle are distinct and vary according to context or the animal's emotional state, and that the characteristics of these vocalisations differ between individuals (Watts and Stookey, 2000). According to Albright and Arave (1997) and Bouissou et al. (2001), most vocalisations in cattle seem to be related to stress and frustration. According to Watts and Stookey (2000) the presence and actions of people probably have an influence on the vocalisations in farm animals.

Cattle have a great number of odoriferous glands, which implies that olfaction is important in communication with conspecifics (Bouissou et al., 2001). Cattle use both olfactory systems, consisting of olfactory bulbs and the vomeronasal organ and olfaction is a help in identifying individuals, thus being important in social relationships (Bouissou et al., 2001). The flehmen response in cattle, i. e. when the animal elevates the head and curls the upper lip, is a common response to urine and vaginal secretions and by doing so, odours come in contact with the vomeronasal organ (Albright and Arave, 1997; Bouissou et al., 2001).

Tactile communication in cattle is of great importance in maternal behaviour, sexual behaviour, when establishing a hierarchy and in social relationships (Albright and Arave, 1997; Bouissou et al., 2001). However, as stated by Bouissou et al. (2001), tactile communication is the least documented form of communication in cattle.

3.1.3. Abnormal behaviour

Stereotypies, which can be seen as a form of abnormal behaviour, are unvarying, repetitive behaviours, which appear to have no direct function or aim (Mason, 1991). According to Mason (1991) stereotypies have been used to assess the welfare of animals, since they are often an indicator of unfavorable factors in the environment. Oral behaviours, e.g. intersucking and tongue rolling, are the most frequent forms of abnormal behaviour in cattle (Winkler et al., 2003).

3.1.4. Dominance and aggression

Social interactions can be separated into agonistic and non-agonistic interactions (Sato et al., 1993; Bouissou et al., 2001). Agonistic interactions include aggressive and avoidance behaviours, while non-agonistic interactions include sexual behaviour and social grooming (Bouissou et al., 2001).

Beilharz and Zeeb (1982) state that dominance can be defined as the inhibition of one animal's behaviour by the presence of another animal, and that the dominance order within a group is the sum of all dominance relationships. These dominance relationships assist in resolving conflicts caused by proximity (Bouissou and Boissy, 2005). The words aggression and dominance are often related, and may therefore sometimes be confused, hence the importance of clarifying the meaning of these concepts. As stated above, a definition of dominance is that one animal inhibits the behaviour of another, while aggression is when one animal repells another through expression of behaviours (Beilharz and Zeeb, 1982). Therefore, a dominant animal does not necessarily have to be aggressive, even though it might have been so in the past to aquire its dominant status (Beilharz and Zeeb, 1982). Beilharz and Zeeb (1982) also state that once the dominance relationship is established it is maintained through learning and no further aggression is needed.

Aggressive interactions are not only peformed in relation to the establishment of social rank, but are also common in competition for resources such as lying areas, food and water (Albright and Arave, 1997; Rousing et al., 2000). The welfare of an animal in a group with limited resources is partly determined by its dominance position in relation to the other members of the group, i.e. how many animals are higher in rank and how many are lower (Beilharz and Zeeb, 1982). Social stress and aggressive interactions can also be caused by poor design of the housing environment and through pain and frustration (Rousing et al., 2000). Aggression in a group can lead to poor welfare of individuals who are being chased, displaced from resources or injured (Rousing et al., 2000). However, Rousing et al. (2000) also argue that aggression can not only lead to poor welfare of the bullied animal, but the aggression itself can also indicate reduced welfare of the animal displaying aggressive behaviour, since it can be a result of stress and tension.

Crowded conditions can also reduce the welfare of individuals in a group since subordinate animals will be forced to move around in an attempt to avoid dominant animals, since they cannot keep individual distances (Bouissou et al., 2001). The group size is thought to have an impact on the level of agonistic behaviours within the group (Lindberg, 2001). Since small groups should have a simple and stable hierarchy the necessity for aggression should be low, while the relationships within a larger group are usually more complex and changes of dominance might be more frequent, which raises the level of agonistic behaviour (Lindberg, 2001).

3.1.5. Allogrooming and social licking

Cattle have preferential relationships, expressed through positive social behaviours such as allogrooming (Bouissou and Boissy, 2005). According to Albright and Arave (1997) the grooming of their own haircoat and the haircoat of conspecifics is a good sign of general health and wellbeing. Allogrooming in cows is suggested to be an important behaviour in the establishment, stabilisation and maintenance of social relationships (Sato et al., 1993). Normally, a subordinate individual is not allowed to approach a dominant, nevertheless, subordinates may every now and then perform allogrooming of the dominant, hence suppressing its aggressive behaviour (Sato et al., 1993). Sato et al. (1991) imply that social licking could have a bonding, calming and cleaning effect. The calming effect is supported by observations of cattle half closing their eyes while being licked (Sato et al., 1991). In a study by Val-Laillet et al. (2009) the body parts most frequently allogroomed was the head and neck regions, which supports the hypothesis of the cleaning function of the behaviour, since the head and neck regions are inaccessible to the reciever. According to observations by Sato et al. (1991) solicitation for social licking was performed by both dominant and subordinate individuals. In the same study solicitated licking was usually directed towards the head and neck while unsolicitated licking also was oriented to the back and rump. In solicitation for licking, one animal approaches another animal's mouth with its cheek, or gives a gentle push with the nose towards the cheek of the other animal (Sato et al., 1991).

In a study of cattle performed by Sato et al. (1993) familiarity and kinship between the animals had an effect on time devoted on allogrooming, while dominance order had no effect. A study by Val-Laillet et al. (2009) also showed no effect by dominance order on the expression of social grooming.

3.2. Aim

The aim of this study was to compare the behaviour and activity level of dairy breeding bulls kept individually or in groups, and to evaluate which of these housing systems is the best regarding the welfare of the bulls. The following questions were asked:

1. Do the bulls have a higher activity level in the group housing than in the individual housing?

2. Is there a higher level of social interactions in the group housing than in the individual housing?

3. How much aggressive interactions do the bulls have and are they more common in group housing than in individual housing?

4. Do the bulls show any abnormal behaviours and are these more common in individually housed bulls?

4. MATERIAL AND METHODS

This study was conducted in April 2010 at VikingGenetic's facility in Torsholm, Falkenberg in the south of Sweden. The study was approved by Gothenburg Research Animals Committee (dnr. 52-2010) before it started.

4.1. Bulls and housing

The bulls chosen for the observations were from 34-60 months of age and of the breeds Swedish Holstein and Swedish Red (See tables 1 and 2). Eight bulls from individual housing were selected, and thereafter eight bulls, one per group, were matched to each individually housed bull regarding age and breed. Bull no. 1 was matched to bull no. 9; bull no. 2 was matched to bull no. 10 etc. (Tables 1 and 2). In each of the housing systems four Swedish Holstein and four Swedish Red were chosen. In the group hosing system bulls with recognisable patterns were chosen to avoid marking the animals as far as possible. However one of the bulls (no. 10) was marked on the sides and back using a shearing machine. The hooves of all the bulls in the study were trimmed 3-5 days prior to the beginning of the study.

Table 1. ID, age and breed of individually housed bulls

Bull ID	Age (months)	Breed
1	45	Swedish Red
2	45	Swedish Red
3	39	Swedish Red
4	37	Swedish Red
5	60	Swedish Holstein
6	49	Swedish Holstein
7	36	Swedish Holstein
8	34	Swedish Holstein

Table 2. ID, age, breed, pen and number of bulls per pen of group housed bulls

Bull ID	Age (months)	Breed	Pen	Number of bulls in pen
9	46	Swedish Red	6	5
10	38	Swedish Red	16	11
11	37	Swedish Red	20	7
12	37	Swedish Red	11	8
13	56	Swedish Holstein	9	4
14	49	Swedish Holstein	19	4
15	40	Swedish Holstein	12	8
16	36	Swedish Holstein	13	6

The pens in the individual housing were 2,5 m x 10 m and the flooring was divided into three parts (Fig. 1). One part had straw bedding and two parts had concrete flooring, one in the middle of the pen and one by the mangers. In the middle section of the pens the spaces between gate bars were wider (40 cm) than in the rest of the pen. These gates were called "social gates" and enabled the bulls to put their heads in between the bars and have social interactions with their two neighbours (Fig. 1). The bulls could have social interactions with one other bull when having their heads out through the headlocks by the mangers. The mangers and water bowls were placed so that two bulls shared one long manger and one

water bowl. The building with individual housing consisted of 38 pens, 19 pens on each side of the aisle with mangers (Fig. 3). The individually housed bulls in this study were placed in two groups of four bulls next to each other with one group on each side of the aisle.

Figure 1. An example of the pens in individual housing (Photo: Isabel Dahlgren).

The group housing facility consisted of 20 pens (Fig. 3) with the measurements 11 m x 10 m. The pens were divided into two parts, one consisting of straw bedding and one with concrete flooring next to the manger (Fig. 2). The aisle separating the pens was used as a manger. The number of bulls in the selected pens differed from four to eleven individuals. The number of headlocks in the pens were enough to enable all the bulls to eat at the same time. Placed in the middle of each pen was a gate with two water bowls (Fig. 2).The purpose of this gate was to enable the bulls to escape from an attacking pen mate. The gates separating the pens enabled the bulls to have some social interactions with the bulls in the neighbouring pens.

Figure 2. An example of the group housing pens (Photo: Isabel Dahlgren).

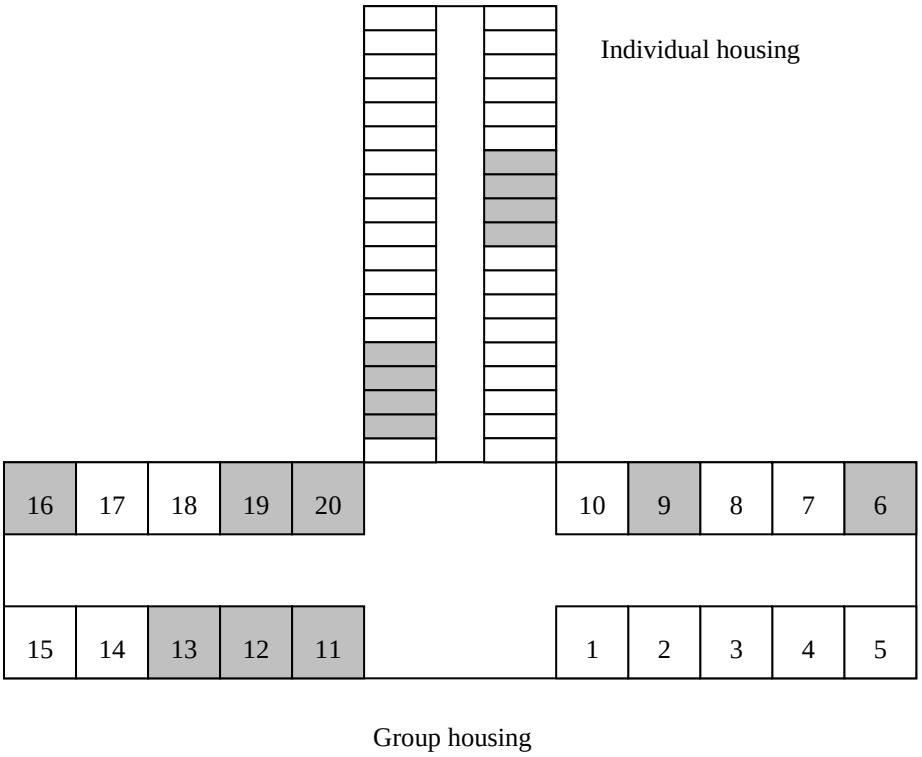


Figure 3. View of the buildings with group housing and individual housing. The bulls used in this study were placed in the grey marked pens.

The bulls in both housing systems were fed once daily in the morning between approximately 8.00 and 9.00 am, except for one day when they were fed between 11.00 and 12.00 am. The individually housed bulls were always fed first. The bulls were fed a mixture of straw, mash, silage, minerals and salt, except for one day when they were fed silage only. In the afternoon every day, the leftovers of the food were pushed together so that the bulls could reach it. The animals also ate the new straw provided in the pen.

The concrete floors were cleaned twice weekly in both housing systems. Each pen in the group housing was given a bale of straw once a week and when necessary. The individually housed bulls were also given straw once weekly and more often if necessary. The straw bedding area in the group housing was cleaned out and replaced by new straw once during the study.

The temperature and humidity in the stables were measured before the beginning of every observation. The mean temperature and humidity over the three weeks of observations were 9.8˚C and 61.8 % in individual housing and 10.2˚C and 60.9 % in group housing.

4.2. Data collection

Data of the behaviours of the bulls was collected through behavioural observations and the use of activity monitors, so called IceTags.

The IceTags 2.004 (IceRobotics, Scottland) were attached to the outside of the right hind leg of the bulls and secured by a Velcro strap and duct tape. The activity monitors were attached three and five days prior to the beginning of the study and a trimming shute was used to enable a safe attachment. The activity monitors recorded how much time the bulls

spent lying, standing and being active. It also recorded the number of steps taken by the animals. This data was collected from 12–28 of April 2010.

To perform the behavioural observations the observer was placed approximately 2.5 m up on top of two bales of straw which were positioned in nine different locations outside the pens with the chosen bulls. This position enabled a good view of the bulls, and lowered their reactions to the observer. The observations were performed between 8.45 and 14.45, four days a week from 12-29 of April 2010. Four bulls were observed each day for one hour respectively and all 16 bulls were observed once every week during three weeks, which gives totally three observation hours per bull. The observation order of the bulls was randomised by lottery for each week of observations. The observation order of the different housing systems was also randomised by lottery and was thereafter systematically alternated. General behaviours were recorded using focal sampling with instantaneous recording with an interval of three minutes. Focal sampling with continuous recording of frequencies was used to record social and abnormal behaviours. One observation lasted for one hour and the general behaviours and social and abnormal behaviours were recorded simultaneously. Before the beginning of the study a pilot study was conducted and two ethograms were made, one with general behaviours and one with social and abnormal behaviours. Ethograms for the general behaviours and social and abnormal behaviours are shown in Appendix 1. Focal sampling was found to be the most useful sampling method since it is performed on one animal at a time and can be used to record a variety of behaviours (Martin and Bateson, 2007). Continuous recording of social and abnormal behaviours was used since the duration of these behaviours is usually short. The general behaviours usually have a longer duration and could therefore be recorded using instantaneous recording.

A paper for every week was given to the caretakers, where they noted down feeding times and other activities performed in the stables. During the three weeks of observations blood samples were taken in pens which were not included in this study, a big cleaning of the dunghills outside the stables was performed during two days, and a number of bulls were moved from the tie-stalls to the group housing pens.

4.3. Data processing and statistical analysis

The IceTag data was transferred from the activity monitors to a computer and then exported to Excel 2002. The median percentages per hour of the behaviours lying, standing and active in the two housing systems were calculated and used to make linear graphs to show the differences in behaviour over the day. The data per 24 hours from the IceTags was imported to SAS (SAS Institute, Cary, USA, vers.9.3), which calculated the means of lying, standing, active and number of steps per bull and day. This was done by dividing the total of the percentages for the different behaviours or number of steps for all days by 17, which was the total number of recording days. These means were used for statistical analysis and to calculate the medians and quantiles for the different behaviours in each housing system. The data collected through behavioural observations was inserted into Excel 2002 and analysed using SAS. The data of general behaviours collected through instantaneous recording was inserted into one file with every instantaneous recording in a separate row, while the data of social and abnormal behaviours was inserted into a new file with the sum of behaviours performed during the observation hour in every row. Data from five observations of general behaviours and social and abnormal behaviours respectively were excluded before the data was imported into SAS. The reason for this is that during

these observations the bulls were locked in the headlocks to enable cleaning of the pens. The data of the general behaviours was imported to SAS which firstly calculated the means of the different behaviours per bull by dividing the total number of instantaneous recordings for all observations by the total number of observations (42-63 observations per bull). From these means the medians and quantiles of every behaviour per housing system were calculated.
The data of the social behaviours was treated the same way. The mean of the different social behaviours per bull and hour was calculated by dividing the total number of recordings for all observations by the total number of observations (2-3 observations per bull). The medians and quantiles of every social behaviour per housing system were calculated from these means. The statistical test used to analyse all the data including the activity data from the IceTags was Wilcoxon rank sum test. This test was used since the data was quantitative and was assumed not to be normally distributed. Since every bull in group housing was matched to a bull in individual housing, a paired t-test could also have been used to analyse the data.

5. RESULTS

5.1. Activity

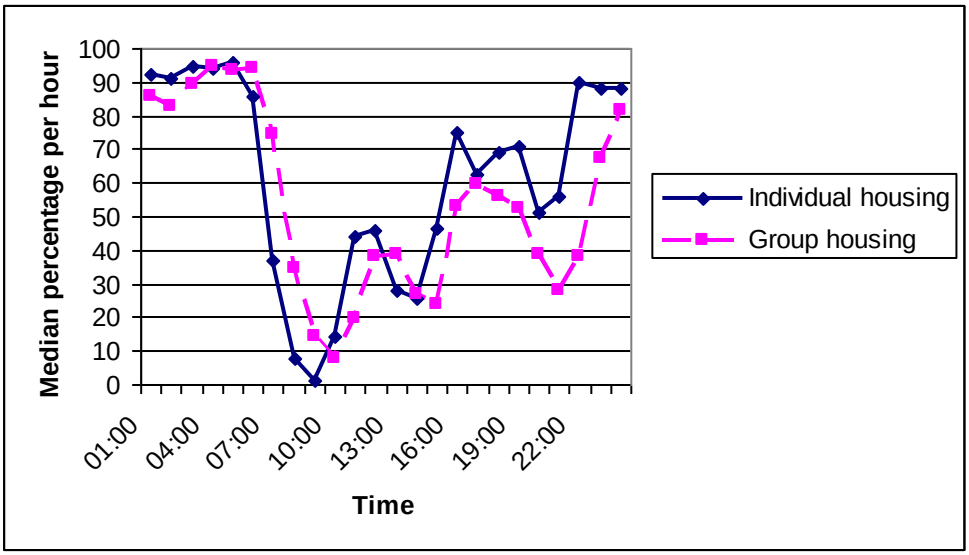
The bulls in group housing were significantly more active ($p < 0.01$) and took a significantly higher number of steps ($p < 0.005$) than the individually housed bulls (Table 3). There was a tendency of more lying behaviour in individual housing than in group housing ($p < 0.1$, Table 3). Bull no. ten took a higher mean number of steps per day than any other bull. He took approximately 3319 steps per day, while the the bull who took the second most steps per day took 1913 steps.

Some of the bulls were occasionally observed licking the IceTags.

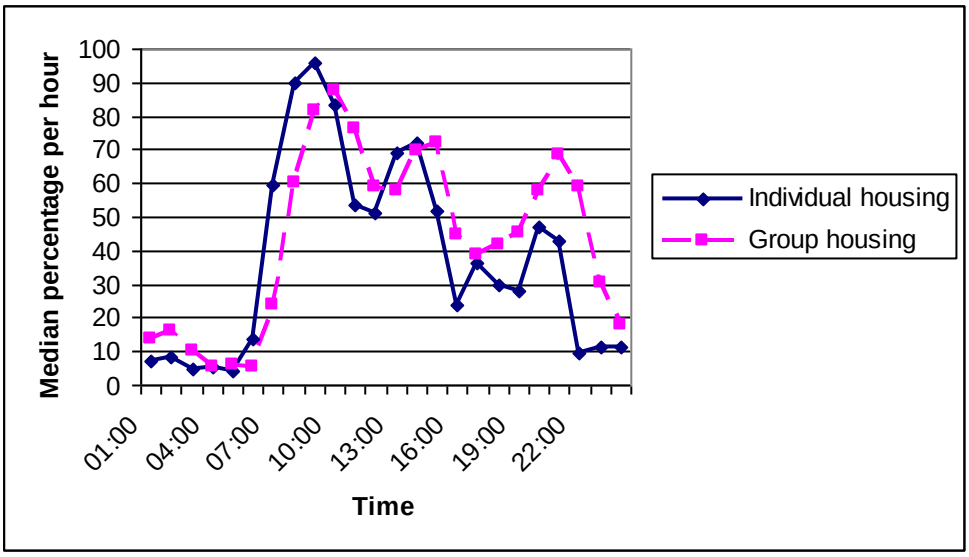
Table 3. Median percentage per 24 hours (Q1, Q3) and p-values for dairy bulls lying, standing and being active, and number of steps in individual housing and group housing.

Behaviour	Individual housing	Group housing	P-values
Lying (%)	59.7 (56.2, 63.3)	54.3 (49.1, 58.7)	0.08
Standing (%)	38.9 (35.1, 41.9)	43.5 (39.0, 47.7)	0.1
Active (%)	1.4 (1.2, 1.7)	2.5 (2.2, 2.8)	0.007
Steps (number)	800.9 (695.0, 974.2)	1515.2 (1246.8, 1795.0)	0.003

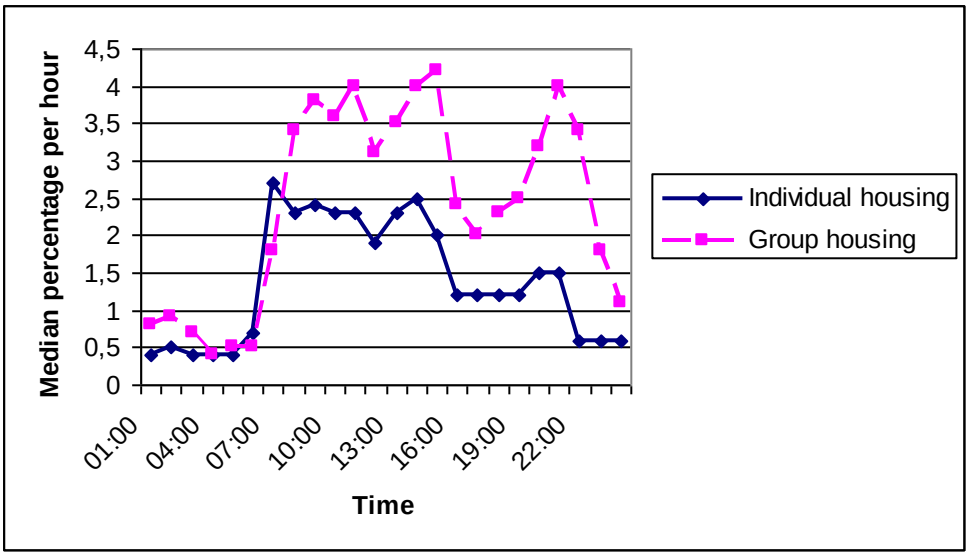
There was a delay of standing (Fig. 4 B) and lying (Fig. 4 A) in group housing compared to individual housing of approximately one hour in the morning.There was a higher percentage of being active in group housing than in individual housing throughout the day (Fig. 4 C).



A.



B.



C.

Figure 4. The median percentages per hour that bulls spent on lying (A), standing (B) and being active (C) in individual housing and group housing.

5.2. General behaviours

The bulls in both housing systems spent the most of the observations "eating" (Fig. 5) and all bulls performed this behaviour. "Standing" and "ruminating" were also commonly performed behaviours (Fig. 5). The observations where the bulls spent "walking", "drinking" and being "social" were few (Fig. 6) and these behaviours were only performed by nine, ten and ten bulls respectively out of the total 16 bulls. The behaviours "lying", "auto grooming" and "rubbing inanimate object" were performed by five, four and six bulls respectively. "Auto grooming" was performed to the same extent in both housing systems. Medians, quantiles, p-values and z-values for all general behaviours can be found in Appendix 2.

The bulls were observed to perform most of the "eating" in the morning and "ruminating" in the afternoon.

No significant differences were found in the performance of any of the general behaviours between individual housing and group housing.

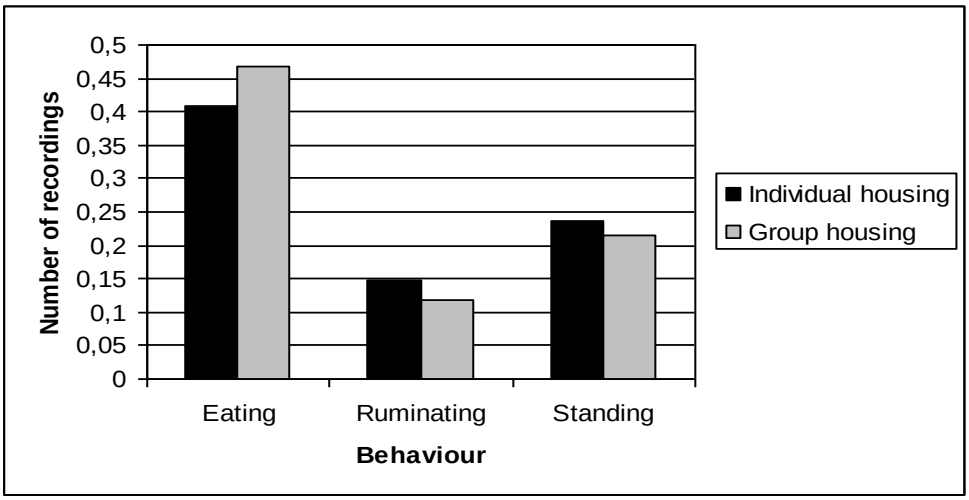


Figure 5. The median number of recordings from 42-63 instantaneous observations of dairy bulls eating, ruminating and standing in individual housing (n=8) and group housing (n=8).

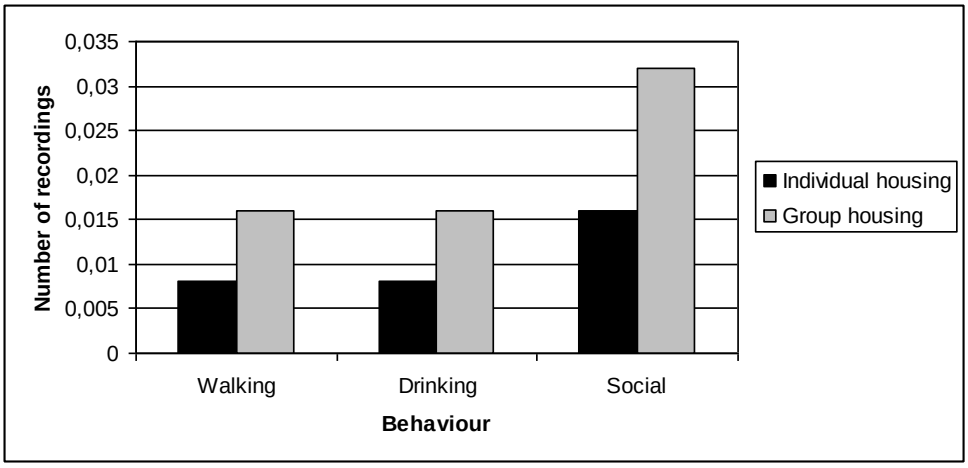


Figure 6. The median number of recordings from 42-63 instantaneous observations of dairy bulls walking, drinking and performing social behaviour in individual housing (n=8) and group housing (n=8).

5.3. Social behaviours

The social behaviour most frequently shown was "sniffing" (Fig. 7). "Pushing" and "vocalising" were also commonly performed behaviours (Fig. 7). However, "vocalising" was performed by eleven bulls totally in both housing systems while "pushing" was performed by all bulls in group housing, but only one bull in individual housing. "Head to head pushing" was performed by five bulls in group housing and one bull in individual housing (Fig. 8). "Rubbing bull" was performed by five bulls in group housing and two bulls in individual housing, while "social licking" was shown by five bulls in individual housing and four in group housing (Fig. 8). Medians, quantiles, p-values and z-values for all social and abnormal behaviours can be found in Appendix 2.

There were no significant differences in social behaviours performed in the different housing systems, except for the behaviour "pushing" ($p < 0.01$), which was significantly more performed in group housing than individual housing.

Figure 7. The median number of recordings per hour of dairy bulls performing vocalisations, sniffing and pushing in individual housing (n=8) and group housing (n=8).

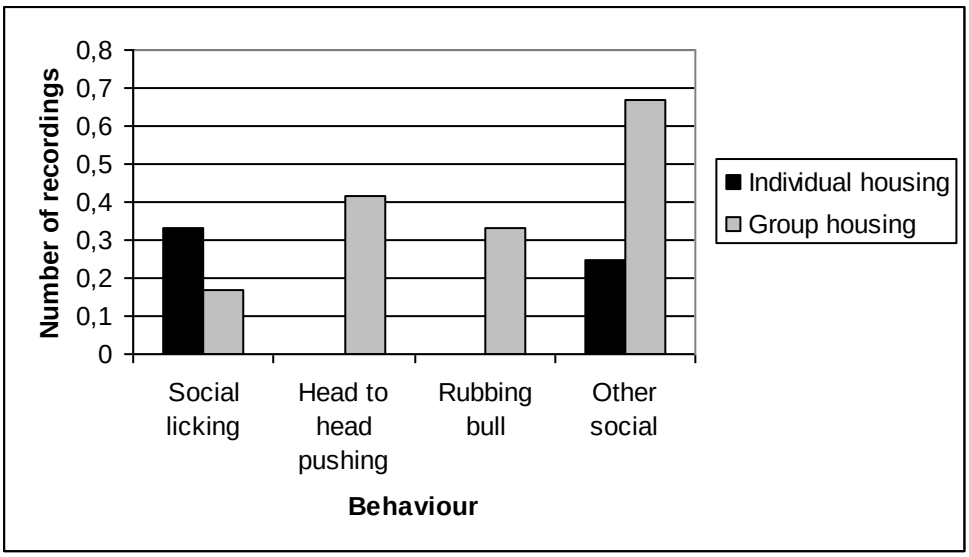


Figure 8. The median number of recordings per hour of dairy bulls performing social licking, head to head pushing, rubbing bull and other social behaviour in individual housing (n=8) and group housing (n=8).

"Mounting" was only observed once during the observations and it was performed by bull no. seven in individual housing. The same bull performed more "social licking", "pushing", "head to head pushing" and "other social behaviour" than any other bull in both housing systems. Another bull (no. six) vocalised more than any other bull, and the majority of these vocalisations were directed towards the observer.

The bulls were also observed to vocalise when caretakers were present in the stables outside of their normal routines, for instance when taking blood samples. Some bulls, both

focal animals and non-focal animals, were observed to vocalise and perform threatening behaviour towards the observer, i.e. lowering the head and horning and pawing the ground.

Other observations which were not recorded are for instance that the flehmen response was perfomed by many of the bulls after sniffing the urine or genitalia of another bull. Sometimes it was also performed after sniffing the body of another bull or when sniffing in the direction of the observer. Mounting behaviour was observed in some of the group pens with younger animals.

The social licking performed was directed towards the head and neck, but also to the body and rump. An observation made of the animals receiving social licking was that they often lowered their heads and half closed their eyes, which was also seen in ruminating bulls.

Both focal animals and non-focal animals in group housing were observed to gently push another bull who was eating, and in response the bull moved and gave place to the pushing bull. Non-focal animals were observed to push a bull who was lying down, until it stood up and walked away.

5.4. Abnormal behaviours

No abnormal behaviours were recorded throughout the study. However, bar biting, directed to the bars close to the observer was observed a small number of times.

6. DISCUSSION

The lower activity level in the individually housed bulls could be seen as a sign that these bulls are less alert since they may not have a reason to move, but it might also just be a result of the smaller area to move around upon than in group housing. If these are the circumstances the higher activity level in group housing would be regarded as a sign of better welfare. However, the higher level of activity in group housing could also be negative, if the reason that they are more active is to avoid other individuals or because they are being pushed or chased by another animal. Thus the level of activity in itself does not tell whether the welfare is good or not, and since the results of this study do not show the reason behind the difference in activity level, it is difficult to use as a welfare parameter.

The times when the group housed bulls were the most active were at around 9.00, 11.00, 15.00 and 21.00, while the individually housed bulls were most active at around 7.00 and 14.00. Except for the evening activity in the group housing, these peaks in activity are not in compliance with the statement by Albright (1993), saying that cattle are crepuscular animals. One reflection is that the circadian rhythm and activity in these bulls probably is affected by feeding times and other management routines. Other results supporting this reflection are that there was a delay of standing and lying in group housing compared to individual housing of about one hour in the morning. The reason for this could be that the individually housed bulls were fed ealier than the group housed ones.

As stated by Albright and Arave (1997) cattle have an innate motivation for movement and one advantage with group housing regarding the welfare of the bulls, could therefore be that they have a larger total area to move around upon than in individual housing (110 m^2 vs. 25 m^2). However, if there are many bulls in a group the area per bull in group housing could be smaller than in individual housing. According to Bouissou et al. (2001) the welfare of individuals in a group can be reduced under crowded conditions since the bulls cannot keep individual distances, and subordinates will therefore be forced to move around to avoid dominant individuals.

The individually housed bulls could have social interactions through the social gates. However, they could only engage in interactions with two other bulls while the group housed bulls could interact with both pen mates and bulls in neighbouring pens. They could have full social interactions with penmates and limited interactions with neighbours. The only social behaviour, which significantly differed between the housing systems was "pushing" ($p < 0.01$), which was significantly more performed in group housing than individual housing. An explanation for this could be that the bulls in group housing pushed each other at the mangers and thereby making the other animal walk away to a different headlock. This was mostly performed during the observations when the animals were eating. Other results supporting this explanation are that all group housed bulls performed "pushing", while it was only recorded for one bull in individual housing.

One positive aspect of individual housing, both economically and regarding the physical health of the animal, is that it is much more difficult for the bulls to injure each other than in group housing. However, the observation of one individually housed bull mounting the head of another, demonstrates that not only the group housed bulls could injure each other. The group housing system can be supported by the fact that cattle are highly social animals as stated by Bouissou and Boissy (2005) and Watts and Stookey (2000). However, since

the individual pens are equipped with social gates, the question to be asked is whether these gates meet the bulls' need for social interactions, which could be a research question for another study. Another thought is if living next to another animal, without being able to perform all types of social interactions, could be frustrating to the animal. Since the spaces in the social gates are wide enough for the bull to place his head and neck into a neighbouring pen the bulls can still perfom many, but not all, forms of social behaviours, although not as readily as in group housing. Positive social interactions such as social licking could be performed in both housing systems, however, it was probably easier for the group housed bulls to perform this behaviour on all body parts than for the individually housed bulls. The bulls receiving social licking were often observed to half close their eyes, which was also found by Sato et al. (1991) and is, according to the same study, thought to be a sign of a soothing effect on the receiver. This was also observed in ruminating bulls. One advantage with group living, also mentioned by Bouissou et al. (2001), could be the group's ability to lower an individual's arousal during a stressful event, such as collecting of blood samples. However, since the bulls in individual housing were placed near each other and could have social interactions there is a possibility that these bulls could have the same calming effect on each other. A negative aspect of individual housing could be that a subordinate individual might be placed next to or in between two dominant bulls, hence reducing the welfare of the subordinate bull since there is no possibility of escaping. Since two bulls share water bowl and manger, a subordinate animal's access to these resources could be restricted by a dominant bull, hence reducing the welfare of the subordinate. Though this could also occur in group housing, the subordinate animal would then have the possibility of trying to escape the dominant animal by moving to the other end of the pen. However, there is a greater risk of injuries in the group housing which could lead to poor welfare, especially for a subordinate bull. The competition for resources in the group housed bulls in this study should be low since the food was spread out and there were enough headlocks for all the bulls to eat at the same time. There were also enough lying area for the bulls to rest simultaneously. The resource for which there could be competition is the two water bowls, but no such competition was observed.

The group size varied from four to eleven bulls, which could have made some groups more stable than others since, according to Lindberg (2001), the dominance relationships within a small group should be more simple and stable than those within a larger group. It would also be easier to keep the individual distances within a small group, and as stated by Lindberg (2001) the level of agonistic behaviours in a group is probably affected by the group size. Bouissou et al. (2001) found that males of three to four years can live in groups of up to ten individuals, while Hall (1986) stated that, in the Chillingham herd, male cattle of more than four years lived together in groups of no more than three animals. The age of the bulls in this study ranged from 34-60 months and an adequate group size, considering the literature mentioned, could be somewhere in between two and ten individuals. A result supporting this is that bull no. ten who was placed in the only group with eleven individuals, took more steps per day than any other bull, which could be a result of the attempt to keep individual distances to other members of the group. However, since the activity was only measured in one bull per pen, the higher number of steps in bull no. ten could depend on other factors such as individual differences or the activity monitor. The results of the activity might have been different had he been excluded from the calculations. To investigate this further a study of the effect of group size on the behaviour of the bulls would have to be conducted. Aggressive behaviours, such as butting and threatening were not observed during this study, which could be a sign that the groups are

stable, since according to Beilharz and Zeeb (1982) once dominance relationships within the groups are established, there is no further need for aggression. Head to head pushing could be seen as an aggressive interaction, especially when performed with conciderable force. However, in the head to head pushings observed during this study little force was used and the bulls were pressing their foreheads against each other, but without one animal pushing the other one backwards.

Bull no. seven in individual housing performed more social licking, sniffing, pushing, head to head pushing, rubbing bull and other social behaviour than any other bull in individual housing and most of the times even more than any other group housed bull. If he would have been excluded from the calculations, the distribution of social behaviours in the two housing systems might have looked different. Another bull who distinguished himself from the others was bull no. six who vocalised more than any other bull. The majority of those vocalisations were, however, directed towards the observer and sometimes towards a caretaker. This could be seen as a sign of stress considering the statement made by Albright and Arave (1997) and Bouissou et al. (2001) that many vocalisations in cattle seem to be related to stress and frustration. However, Watts and Stookey (2000) stated that the understanding of vocalisations in cattle is poor. Yet, the observations of bar biting directed towards the observer could also be seen as an indicator that the presence of the observer was stressful to some bulls. A few bulls vocalised and performed threat displays towards the observer while other bulls did neither. Even though some bulls did not visibly react to the observer they might have been affected by the pen mate's or neighbour's reaction. These findings are in agreement with the statement by Watts and Stookey (2000) who wrote that the vocalisations in cattle probably are influenced by people in their surroundings.

Since this study was performed on a farm, unforeseen events easily occur which make management routines difficult to standardise. The bulls' behaviours and hence, this study, have probably been affected by these unstandardised conditions such as cleaning, different feeding times, transfer of bulls and other activities.

Some of the individually housed bulls were relocated five days prior to the beginning of the study to facilitate the observations. This means that most of the bulls in individual housing had at least one new neighbour and therefore a new establishment of rank might have been needed. This would temporarily raise the levels of tension and aggression as stated by Albright and Arave (1997) and Rousing et al. (2000), and could hereby have had an effect on the results.

The attachment of the IceTags was probably a somewhat stressful event since the bulls were led to the trimming shute, where their hoofs were trimmed and IceTags attached. This might have affected the behaviour of the bulls afterwards. However, this was performed five and three days before the observations started and was done on all animals included in the study, and should therefore have a similar effect on the bulls in each housing system. The bulls might have been somewhat affected by the IceTags themselves throughout the study, since some bulls were observed licking them, which could have affected their behaviour in general. However, this should not have affected the bulls in one housing system more than the other.

One important aspect to remember when talking about the behaviours of the individuals in this study, is that the bulls affect each other, both in the same housing system and between the housing systems, through for example vocalisations. Another important aspect to keep in mind is that the behavioural observations only were performed between 8.45 - 14.45. The results might have been different if the data would have been collected at a different time or throughout the entire day. For instance, the data from the IceTags showed a peak in the activity level in group housing at around 21.00, which could have been an interesting time to perform behavioural observations.

There were no significant effect of the two housing systems in the behaviours investigated, except for "pushing", which could mean that there is no difference regarding the welfare of the bulls. However, this was a limited study conducted on few animals, from morning til afternoon for a short period of time. If it would have been conducted on more animals, for a longer period of time and throught the entire day the results might have been different. Future research within housing of breeding bulls could include investigation of other parameters, such as stress, rank order, production, physical health, group size and more aspects of social behaviour.

7. CONCLUSION

The higher activity level and number of steps taken in group housing could be regarded as either positive or negative. Since the reason for the difference in activity level is unknown, the results of activity in this study are difficult to use as a welfare parameter. There was no difference between the two housing systems regarding general and social behaviours shown except for the behaviour "pushing", which was more common in group housing. This could mean that the individual housing gives the bulls the opportunity to have enough social interactions. However, a larger study might have given other results. Few aggressive interactions were shown and there was no difference between the two housing systems, which could imply that the groups are stable and have an established rank. No abnormal behaviours were recorded throughout the study. To answer the question of which of these two housing system is the best regarding the welfare of the bulls, more research would have to be conducted. This research could include stress, production, physical health, group size and more aspects of social behaviour. It could also be conducted on more animals, for a longer period of time and throughout the entire day, which could be facilitated by the use of video cameras. This study could be used as a pilot study for further reseach within housing of breeding bulls, which is an area where little research has been performed.

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APPENDIX 1

Ethogram of general behaviours

Behaviour	Definition
Eating	Picking up food or straw with its mouth and chewing on it.
Ruminating	Regurgitating food, chewing and swallowing it again while standing or lying down.
Standing	Standing up on all four feet without performing any other behaviour.
Lying	Lying down with the belly touching the ground without ruminating.
Walking	Lifting a leg and moving forward.
Drinking	Keeping muzzle within 5 cm of the water bowl and swallowing water.
Auto grooming	Stretching out tongue and licking its own body or lifting a leg and scratching itself.
Rubbing inanimate object	Touching an inanimate object with head or body and moving back and forth.
Social	Performing a social behaviour towards one or more bulls.
Other	Other general behaviour which is not described above.
Invisible	Bull is out of sight to the observer.

Ethogram of social and abnormal behaviours

Behaviour	Definition
Vocalising	Making a sound through the mouth.
Social licking	Stretching out tongue and touching another bull with it repeatedly.
Licking urine	Stretching out tongue and touching another bull´s urine with it.
Sniffing	Pointing muzzle towards another bull and inhaling.
Mounting	Jumping up and standing with hind legs on the ground and front legs and front part of the body on top of another bull.
Pushing	Placing forehead or side of the cheek against another bull and pushing.
Butting	Directing a blow with forehead at the side or rump of another bull.
Pushing head to head	Two bulls standing up and pushing forehead to forehead.
Rubbing bull	Touching another bull with head or body and moving back and forth.
Threatening	Lowering head and showing forehead to another bull. Can be followed by rubbing head on the ground and pawing.
Chin pressing	Pressing underside of chin on top of the body, head or rump of another bull.
Other social	Other social behaviour which is not described above.
Tongue rolling	Stretching out tongue and rolling it in the air.
Leaning	Pressing forehead towards the body of another bull, without any reaction from either of the bulls.
Nose pressing	Pressing muzzle towards a hard object in the pen.
Other abnormal	Other abnormal behaviour which is not described above.

APPENDIX 2

The median number of recordings, Q1, Q3, p-value and z-value for dairy bulls performing general behaviours and social and abnormal behaviours.

General behaviours				
Behaviour	**Median (Q1, Q3)**		**p-value**	**z-value**
	Individual housing	**Group housing**		
Eating	0.41 (0.23, 0.64)	0.47 (0.43, 0.56)	0.563	- 0.578
Ruminating	0.15 (0.06, 0.22)	0.12 (0.04, 0.19)	0.713	0.368
Standing	0.24 (0.15, 0.29)	0.21 (0.10, 0.31)	0.753	0.315
Lying	0 (0, 0.07)	0 (0, 0.06)	0.750	0.319
Walking	0.01 (0, 0.02)	0.02 (0, 0.05)	0.543	- 0.608
Drinking	0.01 (0, 0.02)	0.02 (0.01, 0.03)	0.446	- 0.761
Auto grooming	0 (0, 0.01)	0 (0, 0.01)	0.945	0.069
Rubbing inanimate object	0.01 (0, 0.03)	0 (0, 0.02)	0.398	0.846
Social	0.02 (0, 0.03)	0.03 (0, 0.04)	0.665	- 0.433
Other	0.02 (0, 0.07)	0.02 (0.01, 0.04)	1.000	0.000
Invisible	0 (0, 0)	0 (0, 0)	-	-

Social and abnormal behaviours				
Behaviour	**Median (Q1, Q3)**		**p-value**	**z-value**
	Individual housing	**Group housing**		
Vocalising	1.33 (0.25, 3.17)	0.42 (0, 1.17)	0.285	1.068
Social licking	0.33 (0, 0.75)	0.17 (0, 1.17)	0.912	0.110
Licking urine	0 (0, 0.33)	0 (0, 0)	0.267	1.109
Sniffing	0.75 (0.33, 2.33)	2.17 (0.83, 3.00)	0.399	- 0.844
Mounting	0 (0, 0)	0 (0, 0)	-	-
Pushing	0 (0, 0)	1.33 (0.67, 1.83)	0.0098	- 2.583
Butting	0 (0, 0)	0 (0, 0)	-	-
Head to head pushing	0 (0, 0)	0.42 (0, 1.33)	0.115	- 1.575
Rubbing bull	0 (0, 0.33)	0.33 (0, 0.33)	0.350	- 0.935
Threatening	0 (0, 0)	0 (0, 0)	-	-
Chin pressing	0 (0, 0)	0 (0, 0.33)	0.267	- 1.109
Other social	0.25 (0, 1.33)	0.67 (0, 1.67)	0.701	- 0.384
Tongue rolling	0 (0, 0)	0 (0, 0)	-	-
Leaning	0 (0, 0)	0 (0, 0)	-	-
Nose pressing	0 (0, 0)	0 (0, 0)	-	-
Other abnormal	0 (0, 0)	0 (0, 0)	-	-