

Individual Cattle Lying Behaviour



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1. Summary

Nowadays cows spend more and longer time inside, mostly in modern cubicle housing systems. However, free range housing is becoming more popular. In these systems and also on pasture, cows spend almost 15 h/d lying down.

There are various aspects to investigate lying behaviour of cows in the pasture: magnetic body alignment, different cow postures and lateralization. Objective of this study was to determine if there is a pattern in natural individual cow lying behaviour. If this individual pattern in lying behaviour in the pasture is not possible in a cubicle housing system, improving and adjusting this system is an option.

During five weeks four different herds were observed by two observers. The observations took place by scan sampling, through binoculars. The observations were done between 3 and 4 hours after milking, when most of the cows were lying, so that was the best moment to start with the observations. Between observations the cows had to have moved, otherwise the same situation would be observed twice.

Most of the observed cows (2111 observations across four herds) prefer to lie in the N-S direction (55.5 %); this value differed from the expected 50 %. But there were important herd differences. Of a total of 2115 observations, cows show a clear preference for lying in the long resting position, 87.4%. Cows have needs for the other three resting positions, therefore they need enough lying space. No difference was observed between left and right side lying behaviour. Across all four groups (total of 2111 observations), 50.5% lie on their left side and 49.5% of the cows lie on their right side. After analysing the collected data, a relationship between cow laterality and magnetic alignment was found ($P < 0.0001$).

These results cannot prove that the modern cubicle housing system is not suitable to cow individual lying behaviour. Various internal and external factors are not excluded in this investigation. However, this study indicates that the cubicle system needs to be investigated further in this respect.

Keywords: Lying behaviour, cubicle, cow comfort, magnetic body axis, postures, lateralization

2. Introduction

In the areas with a moderate climate of the northern hemisphere, cows are usually housed “indoors” during the winter and at an increasingly number of farms during summer as well.

Pasture provides certain benefits for cows: a more natural environment, possibility to perform behaviour that may be important to them (grazing) and a lower incidence of diseases (lameness and mastitis).^{8,10} However, cows can also benefit from conditions provided indoors, most notably access to a high-quality diet and protection from environmental extremes.¹⁰ Free range housing (figure 1.) is an increasingly popular choice for new dairies in order to maximize stocking density and management efficiency.¹¹ In this system cows are walking and lying freely in one large space without alleys and dividers.

Dairy cattle in a comfortable environment, spend between 12 and 15 h/d lying down, that is more than half of their lives.^{12,5} Cows need to spend time lying for maximum feed efficiency, optimum health (think about preventing lameness) and to ensure good welfare.⁹ When cow-lying-time is reduced, physiological changes associated with stress and eventually a negative impact on health is at risk.³ Cow restlessness and body injuries point to discomfort or obstructions to normal lying positions.¹

Many studies have been conducted on the lying behaviour of individual cows.^{4,6,11} Several indices are used to evaluate cow comfort in free stall housing.^{1,11} To evaluate the quality of housing, lying behaviour can be used, for example how much time do the cows spend lying down and how often do they lie down. In general, it is important to provide a well-designed space fitted for this lying behaviour.

Recently it is reported that domestic cattle across the globe, align their body axes in roughly a north–south direction. Magnetic alignment is the best explanation for the body axis orientation, wind and light conditions are excluded.³ However, not much is known of the position of lying cows in relation to other cows and their individual posture when lying down. In free stall barns, cows are forced to lie in one direction, next to each other in a row in a confined space.

It is interesting to investigate how cows are individually positioned and what their posture is when they lie in the pasture. If there is a pattern in their individual lying behaviour, it could be possible to see if cows can show this behaviour in a modern cubicle housing system as well (figure 2.).



Figure 1. Free range housing



Figure 2. Cubicle housing system

Furthermore, in the cubicle housing system the lying position is limited. In a free range barn all lying postures can be chosen. Four lying resting positions can be described: long, short, wide and narrow (figure 3).¹ For the welfare of the cattle it is, therefore, important to know how often they lie in different lying postures, when allowed. A comfortable housing system has enough space for normal rising (open forward space) and lying motions. When cows' individual lying behaviour in the pasture is not possible in a cubicle housing system, it might be an argument to adjust the housing system.

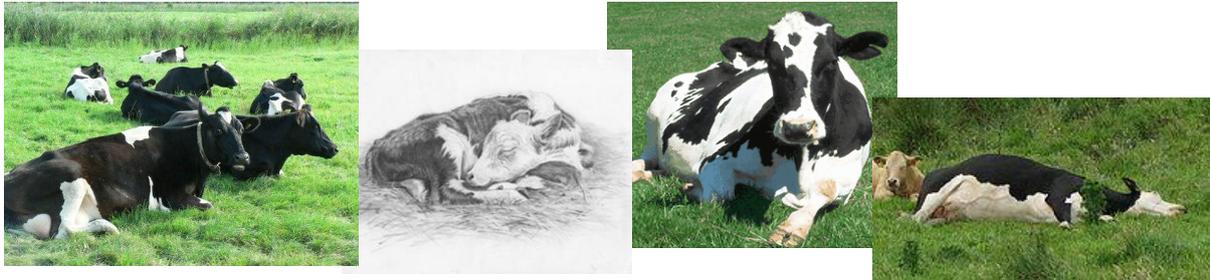


Figure 3. Different cow resting positions: several cows in long posture, calf is lying short, cow in narrow position and a cow is lying in the wide resting position

3. Aim of the study

The study is about individual cattle lying behaviour in pasture. The study is divided in two parts, one part is about the individual lying behaviour and the other part is about lying position in relation to each other; this study will be done by Drs. J.A. Lemmens.

Most studies deal with one aspect of individual lying behaviour. The goal of the present study is to investigate different aspects of lying behaviour and to find a relation between them.. This is focused on three different aspects: how body axes are aligned with the magnetic axis of the earth (north/south or west/east), which body posture cows prefer (four different lying postures can be distinguished) and if cows lie more on their left or right side.

The aim of this study is to find a pattern in individual lying behaviour. The question is if they can show this behaviour in a modern cubicle housing system? Individual lying behaviour can give information about how well the present cubicles are adapted. When their individual lying behaviour in the pasture is not possible in a cubicle housing system, a discussion about our modern housing system is born.

4. Material & Methods

The study is performed at the Dairy Production Department of INIA (Instituto Nacional de Investigación Agropecuaria), La Estanzuela, Uruguay. This study observed the individual lying behaviour of different dairy cow herds in a pasture. In order to be able to do a statistical analysis, the investigation used a coding system. Cows in relation to the magnetic axis, the different postures and the left/right position are translated into numbers (see appendix 1).

The data collection was over a six weeks field period. The purpose of the first week was to test and to get familiar with the coding system and to adjust it, if it was not working properly. During three weeks three different herds were observed by the two observers: 'Secca' (n ± 20), 'Sistema' (n ± 35) and 'Mix' (n ± 150). After three weeks the Mix group was separated into a 'Mix' and a 'Nueve' (n ± 20) herd. So during the following two weeks four different herds were observed. The 'Secca' herd was pregnant, non-lactating and the 'Sistema' and 'Mix' herds were non-pregnant and lactating. During the five week period the 'Mix' herd and 'Secca' were continuously moving between different pastures, the other herds stayed most of the time in the same pasture.

3 to 4 hours after the start of morning milking (05.00 am.), most of the cows were lying, so that was the best moment to start with the observations. On the time of the day the observations took place most of the cows had to lie down to get more results.⁴ The observations took place by scan sampling. Between observations the cows had to have moved, otherwise the same situation would be observed twice.

The observations were done through binoculars, at a distance as far away as possible, so the interference between the observers and the herd was insignificant. During the weeks of observation the weather and other conditions and abnormalities like disturbances were written in a logbook, so odd results could be explained later.

The shoulders of the cow were used as reference for determining which direction the cows were facing: north, south, east or west. So not the head, but the shoulders were making the difference between pointing north, east, south or west. This is because the head is very sensitive to distractions. When the shoulders for example were pointing somewhere between north and west, the code was the nearest one. The different pastures had a variation of slopes; the cattle moved from pasture to pasture during the weeks, this provided different slopes.

Roughly, four different lying postures can be distinguished (figure 4).¹ The first posture is named “long”, in this posture the cow lies on her sternum and ventral side of the abdomen with the neck straightened. In the second posture the cow lies on her sternum and ventral side of the abdomen, curled up with the head turned back; this posture is named “short”. In the third position, “wide”, the cow lies on her lateral side, hind legs stretched. In the fourth and last posture, called “narrow”, the cow lies on her sternum and on her lateral side of the abdomen, legs not stretched. Each different posture can be shown lying on the left or right.

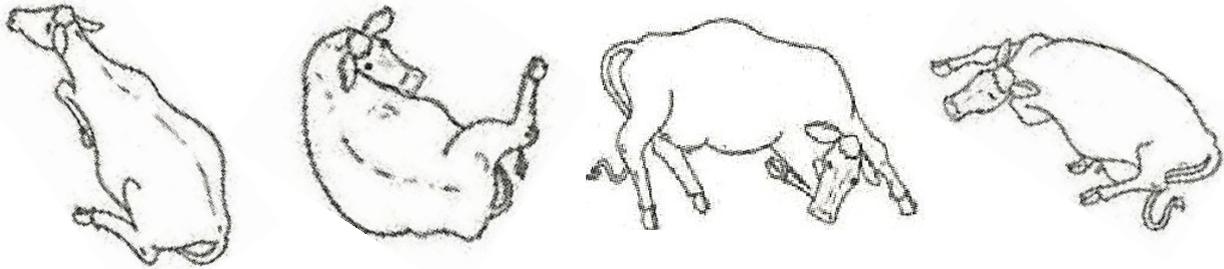


Figure 4. Cow resting positions (long, short, wide and narrow) ¹

5. Results & Discussion

5.1. Magnetic body alignment

Across all four groups, cows prefer to lie in the N-S direction (55.5 %); this value differed from the expected 50 %. But there are marked differences between the four herds: a preference for the N-S magnetic axis has been found in three groups (in the Secca herd the difference is considered to be not statistically significant) and in the Sistema herd there is a clear preference for the W-E direction in contrast with the other herds. These results are presented in Table 1.1. In this experiment wind and light conditions cannot be excluded, because the experiments took place in the same area in a period of only five weeks.

Table 1.1.
Magnetic body alignment

Herd	No. of observations	Axis		Statistically different?
		N-S (%)	W-E (%)	
Secca	233	54.5	45.5	No (P = 0.17)
Sistema	555	38.3	61.7	Yes (P < 0.0001)
Mix	1083	61.9	38.1	Yes (P < 0.0001)
Nueve	240	67.1	32.9	Yes (P < 0.0001)
Total	2115	55.5	44.5	Yes (P < 0.0001)

Statistics for axial direction of four different cow herds. N-S direction versus W-E direction are shown in percentages, also the statistical different is given in P value.

Recent articles describe that cattle align their body axes (when grazing and resting) with a significant preference for a rough N-S direction. Those reports claim that wind and light can be excluded as a common denominator determining the body axis orientation, but this is not completely true.³ Light cannot be excluded, because this experiment used satellite images and therefore you need sunny weather.

This study found slightly different results. Overall, the cows prefer to align their body axes in a N-S direction, but this could be because of the bigger 'Mix' herd. According Table 1.2. there is no difference (P= 0.4) between body alignment when the 'herd total' is created by counting the three herds Secca, Sistema and Nueve together. One of the groups not only influences the final results, but there is also a whole different result. Herds moved from one meadow to another during the observation weeks, that resulted in a small variation in slopes. In continuation of this study, it is better to measure the different slopes. This study did not investigate if the variation in slopes is the right explanation for the different herd results.

Table 1.2.
Magnetic axis

Herd Totals	No. of observations	Axis		Statistically different?
		N-S (%)	W-E (%)	
Secca, Sistema, Mix, Nueve	2115	55.5	44.5	Yes (P < 0.0001)
Secca, Sistema, Nueve	1029	48.7	51.3	No (P = 0.400)

Statistics for axial directions are given; the different herds are counted together in different compositions.

5.2. Postures

Looking at different cow postures is one of the indices to judge cow comfort.¹ In this investigation all groups show a clear preference for lying in the long position, Table 2.1. Eventually 87.4 % of the total 2111 observations is the long posture (figure 4.) instead of one of the other three resting postures.

Table 2.1.

Different cow resting postures

Herd	No. of observations	Posture			
		Long (%)	Short (%)	Wide (%)	Narrow (%)
Secca	233	89.3	7.7	0.0	3.0
Sistema	555	87.7	5.8	1.3	5.2
Mix	1083	87.4	8.3	1.1	3.2
Nueve	240	84.6	12.9	1.2	1.2
Total	2111	87.4	8.1	1.0	3.5

The number of observations are translated into percentages and represented by herd. Across all four groups 87.4% of the cows has a preference for the long resting position.

It is no coincidence that most of the cows prefer the long resting position. Cows in the short position go into active sleep, the head is along the side.¹ When cows lie in the wide position it is mostly only for a very short period and could sometimes be confused with normal rolling. The narrow position seems to be more a transition posture from long to short and vice versa, this posture is not often seen. Furthermore, the long posture looks the most suited posture for rumination; this is a long and important day activity of the cow.

It was expected that high productive dairy cows lie more on their lateral side when their udder is full than when their udder is empty, to relief their udder. The cows in this study are not high yielding, that means that their udders are not as full as with high productive cows.



Figure 4. Cow in long resting position

In this investigation, few cows were observed lying in the other three resting postures; this does not mean that they never lie in those positions. For example, in the investigation more cows were lying in the wide resting position than officially noted down, because a lot of cows (in all groups) lie in this posture for only a few seconds. It is clear that cows prefer the long posture the most for rumination and resting (87.4 %), but they have needs for other lying positions as well. In continuation of this study it is advisable to measure how much time cows spend in the different resting positions and how much space those resting positions take. With this future knowledge, the adaptation of the cubicles can be judged better.

At last a marginal comment; in this research resting postures were observed by day, at that moment most of the cows are eating, ruminating, others are in an active sleep (short posture) and some herds were milked twice a day. Cow resting postures were not observed during the night. It is advisable, before really judging, maybe rejecting, the modern cubicle housing system, to do research of the cow resting postures by night as well.

5.3. Left or right lying side

In this part of the investigation, no differences in laterality were found. Across all four groups (total of 2111 observations), 50.5% lie on their left side and 49.5% of the cows lie on their right side. According to the results in Table 3.1., no difference was found, at herd level there was no preference lying on the left or right side to the other side. Also no statistically difference across all four groups was found, $P = 0.65$. The table also shows that there are no differences between the non-pregnant/lactating herds ('Sistema', 'Mix' and 'Nueve') and the pregnant/non-lactating ('Secca') herd.

Table 3.1.
Laterality of individual cow lying behaviour

Herd	No. of observations	Lying side		Statistically different?
		Left (%)	Right (%)	
Secca	233	49.4	50.6	No ($P= 0.84$)
Sistema	555	52.6	47.4	No ($P= 0.22$)
Mix	1083	49.9	50.1	No ($P= 0.94$)
Nueve	240	49.6	50.4	No ($P= 0.90$)
Total	2111	50.5	49.5	No ($P= 0.65$)

The cows' choice of lying side in different herds. The numbers of observations are translated into percentages and statistical differences are given in P values.

Previous reports give no clear view whether cows show a laterality in their lying posture.^{2, 13} Articles that describe no differences, however, did not identify individual cows nor followed the cows over a 24-h period.¹³ Internal (comfort, pregnancy and rumen fill) and external factors (bedding and the slope of the pasture) play a role in the different investigations.^{5, 12} For example: cows in late gestation spend less time on their right side because of comfort. In another report cows prefer to lie with their dorsal side uphill.^{2, 5}

The present study did observe four herds in different pastures; ultimately no differences in laterality were found. Different lactation stages (no high productive cows) are compared. On the other hand: different gestation stages are not observed, individual cows have not been identified, sides switching was not observed and cows have not been followed over a 24-h period. In future investigations it is advisable to look for individual preference: do cows have preference for one side or another and what is the reason for switching sides? Because of the fact that the cows could not be identified individually in the present study, this was not included.

5.4. Lateralization versus magnetic body alignment

Before starting this research and observations, no connection between cow lateralization and magnetic body alignment was expected (H_0). After analysing the collected data, a relationship between cow laterality and magnetic alignment was found ($P < 0.0001$) (Tables 4.1. to 4.4.).

Table 4.1.
Secca Left or Right * Axis Crosstabs

	North	South	Axis West	East	Total
Left	43 (53.8%)	15	18	39 (72.2%)	115
Right	37	32 (68.1%)	34 (65.4%)	15	118
Total	80	47	52	54	233

With 233 individual observations the Secca herd gives a statistically difference between lateralization and magnetic body alignment ($P < 0.0001$). When lying to the North and East direction cows' had a preference lying on their left side, when lying to the South and West they had a preference lying on their right side. These results are expressed in individual observations and percentages.

Table 4.2.
Sistema Left or Right * Axis Crosstabs

	North	South	Axis West	East	Total
Left	79 (61.2%)	28	38	147 (82.6%)	292
Right	50	55 (66.3%)	127 (77.0%)	31	263
Total	129	83	165	178	555

This research found a statistically difference ($P < 0.0001$), between lateralization and magnetic body alignment in the Sistema herd. The relationship between Axis and lying sides are expressed in number of observations and in percentages.

Table 4.3.
Nueve Left or Right * Axis Crosstabs

	North	South	Axis West	East	Total
Left	74 (86%)	10	11	24 (57.1%)	119
Right	12	65 (86.7%)	26 (70.3%)	18	121
Total	86	75	37	42	240

Also in the Nueve group, with 240 observations, we found a statistically difference ($P < 0.0001$) between lateralization and magnetic body alignment. In this group, for example cows lying to the North had a preference lying on their left side (86%).

Table 4.4.
Mix Left or Right * Axis Crosstabs

	North	South	Axis West	East	Total
Left	136	208 (77.7%)	85	111 (53.6%)	540
Right	266 (66.2%)	60	121 (58.7%)	96	543
Total	402	268	206	207	1083

In the big mix herd this research found a statistically difference between lateralization and magnetic body alignment of $P < 0.0001$. North and South lying side preference were switched comparing with to other herds. Lying side preference for lying in the East and West direction were the same as the other groups.

Across the herds Secca, Sistema and Nueve the cows showed the same preferences. Lying to the North and East cows' had a preference lying on their left side, when lying to the South and West they had a preference lying on their right side. But it could be the other way around? According Table 4.4., the mix herd had other side preferences when lying to the North and South.

Across all four groups, a correlation ($\chi^2 P < 0.0001$) between lateralization and magnetic body alignment has been found, Table 4.5. Lying to the North and West cows had a preference lying on their right side, when lying to the South and East they had a preference lying on their left side. This is the same preference that the Mix herd had, is this result also thanks to this bigger herd? It could be that the total results are influenced by this one herd (also suggested in §5.1.).

Table 4.5.
Total four herds Left or Right * Axis Crosstabs

	North	South	Axis West	East	Total
Left	332 (47.6%)	261 (55.2%)	152 (33.0%)	321 (66.7%)	1066 (50.5%)
Right	365 (52.4%)	212 (44.8%)	308 (67.0%)	160 (33.3%)	1045 (49.5%)
Total	679	473	460	481	2111

Across all groups a difference between lateralization and magnetic body alignment has been found, ($P < 0.0001$). When lying to the right cows had a preference lying to the North and West, when lying on the left they had a preference lying to the South and East.

§5.3. describes that no difference in laterality has been found and in §5.1. are the differences between the body alignments described. The relationship between those indices is never described in any article before. This work proves that there is a correlation, but the data show no more than that. Slopes, wind and foundation should not be excluded in future investigations, because these factors could be an explanation for the herd variations found in this investigation.

6. Conclusion

Each of the indices reported in the current investigation have to be merited in the evaluation of the modern cubicle housing system.

This study found that cattle align their body axes (grazing and resting) with a slight, but significant preference for a rough N-S direction. After analyzing the different resting postures, all groups showed a clear preference for lying in the long resting position. 87.4 % of the cows prefer this posture to one of the other three resting postures. The cows in the pasture showed need for other resting positions, in future investigations research has to be done to the provided amount of space needed for different postures in the cubicle housing system. It could be that there is not enough space for the short and wide resting position in one cubicle. Looking at laterality, no difference across the four herds has been found. Cows choose equally between left and right lying side, no effect of lactation stage or age were found. A relationship between cow lateralization and magnetic body alignment has been found. Cows have a preference lying left or right when lying to a certain axis direction. However, this preference is not completely the same for all four herds studied.

In conclusion, with the present results this study cannot demonstrate that the modern cubicle housing system is fully adapted to cow individual lying behaviour. Too many factors are not excluded in this research. Maybe other stable designs are much more suited to individual cow lying behaviour, for example free range housing. Future investigations to cow comfort indices have to establish this.

7. Acknowledgements

I like to thank the staff of 'Instituto Nacional de Investigación Agropecuaria' (INIA), department of Veterinary Science of Uruguay, for giving me the opportunity to do this investigation. The workers of the INIA farm were very helpful, thank you for your support and your help managing the cows. Also I thank my supervisors Prof. Dr. Daniel Cavestany & Dr. F.J.C.M. van Eerdenburg, for their valuable comment on the investigation. Last but not least, I thank my co-worker Drs. J. Lemmens, for his help collecting all the data.

8. Attachments

Appendix 1

Coding system

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Date					Herd Details					Date Notes		
2													
3													
4	Time	Cow Number		Body Axis	Posture	Left/Right Side		Position	Detailed Position	Nearest Cow Nr		Notes	
5	1												
6	2												
7	3												
8	4												
9	5												
10	6												
11	7												
12	8												
13	9												
14	10												
15	11												
16	12												
17	13												
18	14												
19	15												
20	16												
21	17												
22	18												
23	19												
24	20												
25													
26	Step Forward												
27	No Step Forward												
28	Unknown												

	A	B	C	D	E
1	Code explanation				
2					
3					
4	Quarters of the compass the body axis points at				
5					
6	North		1		
7	South		2		
8	West		3		
9	East		4		
10					
11	Day Time				
12					
13					
14	Posture		Left/Right Side		
15					
16	Long		1 Left		1
17			Right		2
18	Short		2 Left		1
19			Right		2
20	Wide		3 Left		1
21			Right		2
22	Narrow		4 Left		1
23			Right		2

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