

Pasture dairy cattle lying position and rising behaviour

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1 Summary

More and more dairy cattle are housed year-round indoors, mostly in cubicle housing systems, however, pasture provides certain health and behavioral benefits for cows. In cubicle housing systems, cows are restricted in their abilities to choose their own lying position and when they get up, the neck rail makes it impossible to make a step forward.

Nowadays the free range housing systems, which may combine the advantages of the pasture and the cubicle housing systems, are getting more popular.

Cattle spend more than half their lives lying down when kept in the pasture, but when cow-lying-time is reduced, stress and health risks are threatening.

Because lying time is so important, the goal of this study was to determine how dairy cattle in the pasture lie in relation to each other and how they stand up. It is an argument to change the housing system, if this behaviour is not possible in cubicle housing systems.

The aim of this study is to determine how cows are positioned in relation to each other when lying in the pasture; looking at whether the cows lie with their cranial sides together or not and determining at which angle the body axis of the cows are. The second aim of this study, is to see if cows make a step forward during or directly after rising or not.

The data collection was done in Uruguay on a pasture based dairy farm. Four herds were observed for this study for a period of 5 weeks and 1520 observations were made.

Observations were done with bare eyes and the help of binoculars.

Cows lie more often (61,8%) with their cranial sides away from each other than towards each other ($P < 0,00006$), and more often with their body axis in line (59,5%) ($P < 0,00006$) than at an angle.

In 73,7% of the cases (with $P < 0,000$ and with a 95% confidence interval of 0,685 to 0,789), cows make one or more steps forward after rising.

The fact that cows lie more often with their cranial sides away from each other and that they make a step forward during rising in 73,7 % of the cases, shows that the cubicle housing systems are not suitable for these observed behaviours. But knowing that cows on pasture position their body axis in line in 59,5 % of the observations, the cubicle housing system does not impede this behaviour in most of the cases.

2 Introduction

In the Netherlands cows are usually housed “indoors” during the winter and at an increasing number of farms during summer as well.

Pasture provides certain benefits for cows: a more natural environment, performing behaviour that may be important to them (grazing) and a lower incidence of diseases (lameness and mastitis).⁵ Lameness in dairy cattle is associated with the type of housing and intensive management for achieving a higher milk production.⁴ However, cows can also benefit from conditions provided indoors, most notably access to a high-quality diet and protection from environmental extremes.⁵

Free range housing is an increasingly popular choice for new dairies in order to maximize stocking density and management efficiency.⁶ In this system cows are walking and lying freely in one large space without alleys and dividers.

Dairy cattle spend between 12 and 15 h/d lying down, that is more than half of their lives.⁷ Cows need to spend time lying for maximum feed efficiency and for optimum health (think about preventing lameness). When cow-lying-time is reduced, physiological changes associated with stress and eventually a negative impact on health is at risk.³ Several indices are used to evaluate cow comfort in free stall housing.⁶

To evaluate the quality of housing we can use lying behavior, like how much time do they 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 behavior. Many studies have been conducted on the lying behavior of individual cows.^{2,3,6}

However, not much is known of the position of lying cows in relation to other cows and their individual posture when lying. 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 possible that cows do not prefer to lie in a row and close to each other.

It is interesting to investigate how cows are positioned to each other and what their posture is, when they lie in the pasture. If there is a pattern in their lying behavior, it could be possible to see if cows can show this behavior in a modern cubicle housing system. When their lying behavior in the pasture is not possible in a cubicle housing system, it might be an argument to adjust the housing system.

Furthermore, in free stalls the lying position is limited, because cubical partitions are always positioned straight next to each other and also straight across each other. So cows can only position themselves with their cranial sides together either side to side or facing each other with not a lot of room to position themselves at another angle to each other than roughly 0° or 180°. In a free range barn all lying positions can be chosen. For the welfare of the cattle it is, therefore, important to know how much time per day they spend in other lying positions, when allowed.

Furthermore, recent work (unpublished results) indicated that cows after rising make a step forward. The presence of the neck rail in the cubical housing restricts this behavior. It would be interesting to know how often cows do make a step forward after rising, when they are free to do so.

3 Aim of this study

The first aim of this study is to determine how cows lie in relation to each other in the pasture and evaluate if this behaviour is possible in the cubicle housing system. The second aim of this study is to see if cows make a step forward during or directly after rising or not.

4 Materials and Methods

The field work of this research is done at The Dairy Production Department of INIA (Instituto Nacional de Investigación Agropecuaria), La Estanzuela, Uruguay. The in total four herds which are observed consisted of Holstein Dairy Cows. All of the herds were kept outside in the pasture, and therefore their ration existed mainly of fresh grass and alfalfa, besides that each lactating cow was given 4 kg of concentrate each day, divided in two portions of 2 kilograms, given during milking. When the grass wasn't sufficient to feed the cows, corn silage was given to complete the ration. The lactating animals were being milked 2 times a day, at 05:00 a.m. and at 5:00 p.m. in a modern milking barn, with a mean milk production of 6,46 litre per day. Cows were not synchronized, so

The first three weeks of data collection, three groups were being watched, the Secca (n=20), the Sistema (n=35) and the Mix herd (n=150). After the third week of observation, about 20 cows were separated from the Mix herd to form a new group called Nueve (n=20).

The last two weeks of observation there were 4 groups, the secca (n=20), the Sistema (n=35) the Mix (n=130) and the Nueve herd (n=20). The Sistema, Mix and Nueve groups where lactating herds, and the Secca group was a herd of non-lactating cows at the end of their gestation.

Before the five observation weeks, the investigators practiced observing for one week to get experience in observing and to get familiar with the coding system and the behaviour of the cows. During that week the observants watched the position of the cows from a distance of approximately 10 to 40 meters, followed by one from nearby. This way it was possible to check if the first observation was right. The goal was to train observing from a distance, so that the following five weeks of data gathering could be done from a distance so that the investigators would not disturb the cows to get as reliable data as possible.

During the five weeks of data gathering, the investigators observed the herds for 8:00 till 12:00 and from 13:00 till 17:00, every day of the week, except Saturday and Sunday. The observants choose the moment to do an observation, when most of the herd was lying, to get as many data as possible. Between each observation of 1 herd, all the cows of that herd had to be standing; otherwise the same observation was done more than once. Nothing was done by the observants to acquire this, otherwise the investigators would interrupt the behaviour of the cows.

4.1 Determining of the lying position:

To determine how two cows lie in relation to each other, first thing to do is to define how each cow is positioned individually.

Because cows can lie in various postures, it is important to observe where the cranial side of the cow is pointing at following the same standards for each cow.

It is plausible that cows, if they are choosing their position conscious, determine their body position with their heads as most important. However, during the fieldwork, there is not looked at where the heads were pointing at, because the heads move too much. Besides that, looking at where the axis of the back points at, is also difficult to interpret, because cows tend to lie with their back curved.

When a cow straightens its neck in relation to its body, the head is in line with the caudo-cranial line between the shoulders. This position of the head is also its mean position.

Those are the reasons why it is rational to look at the caudo-cranial line through the shoulders to determine where the front of the cow is pointing at.

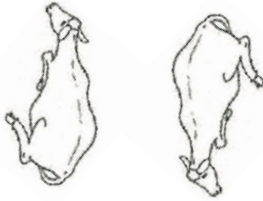
The direction towards the cows were lying, is measured by looking at where the imaginary caudo-cranial line through the shoulders points at.

During the observation, cows were being watched how they were lying only in relation to the nearest cow. If the cows were lying at maximum 2 body lengths away from each other, they were said to lie together. If a cow was lying more than 2 body lengths away from the nearest cow, the cow is said to lie alone. Observations were done, mainly with the bare eye and when the distance was too far, a pair of binoculars were used.

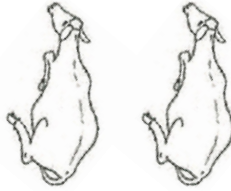
To make statistical analysis of the observations possible, the positions of the cows were recorded using a coding system, so each position has its own number.

When cows were lying with their Cranial Sides Together they would score 1, if not, 0. When lying with their shoulders at 180° or 0° in relation to each other the cows were said to lie “In Line” and they would score 1 for that category and if lying at 270° or 90° they score 0 and the term used for this is “Not In Line”.

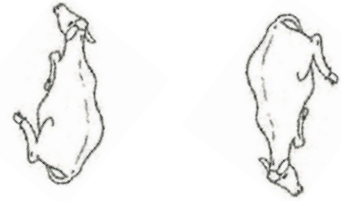
Cranial sides together: 1
 Cranial sides not together: 2
 Body axis In Line: 1
 Body axis Not In Line: 2



Code: 2.1



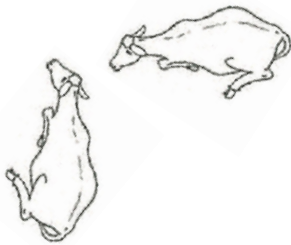
Code:1.1



Code: 2.1



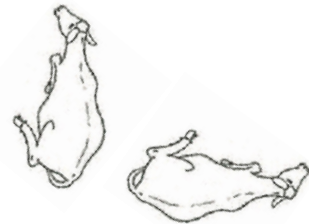
Code: 1.1



Code:1.2



Code: 2.2



Code: 2.2

Figure 1: Explanation of different positions of cows lying in relation to each other and their codes used in this study.⁸

4.2 Rising:

When looking at whether the raising cows did or did not made a step forward during rising, we gave a cow who made one or more steps a 1 and a cow who did not a 0. Cows were only counted as “stepping forward” when not only its legs but also its body was moving forward. This is because cows often put one or 2 feet forward, while keeping their body at the same place. When a cow was directly walking away after or during rising, when it was impeded by another cow or an obstacle, or when the view of the investigators was blocked, the cow was kept out of the data.

5 Results and Statistics

5.1 Cranial Sides:

The observed cows from the different herds together lie more often with their cranial sides away from each other (61.8%) than with their cranial sides close to each other (38.2%) with $P < 0,00006$ using Test 6. The same tendency can be seen within each observed herd, as shown in Table 1.

Herd	% Cranial Sides Together	% Cranial Sides Not Together	N	Significant Yes/No
Mix	38,2	61,8	842	Yes $P < 0,00006$
Sistema	36,4	63,6	363	Yes $P < 0,00006$
Nueve	35,8	64,2	179	Yes $P < 0,00022$
Secca	39,7	60,3	136	Yes $P < 0,0209$
Total	38,2	61,8	1520	Yes $P < 0,00006$

Table 1: Percentages of cows lying with their cranial sides together and lying with their cranial sides not together, the number of observations and the significance for each observed herd and the total of all the herds together.

5.2 Body Axis:

When looking at whether the cows tend to lie In Line or not, they lie more often In Line (59,5%) as they do not lie In Line (40,5%) with $P < 0,00006$ using Test 6. Even though the differences within each herd are not significant, roughly the same tendency can be seen within each observed herd in Table 2.

Herd	% In Line	% Not In Line	N	Significant Yes/No
Mix	60.9	39,1	842	Yes $P < 0,00006$
Sistema	60,6	39,4	363	Yes $P < 0,0001$
Nueve	54,2	45,8	179	No $P < 0,2983$
Secca	54,4	45,6	136	No $P < 0,3472$
Total	59,5	40,5	1520	Yes $P < 0,00006$

Table 2: Percentages of cows In Line or Not In Line, the number of observations and the significance for each observed herd and the total of all the herds together.

5.3 Association between Body Axis and Cranial Sides:

With the Chi squared test of the crosstabulation (Table 3), it is proven statistically, that there is an association between “lying with the cranial sides together or not” and “lying with their body axis in line or not” within the total observations ($P < 0,000$). And also within each single herd (herd Mix, Sistema, Nueve and Secca) the association between “lying with the cranial sides together or not” and “lying in line or not in line” is statistically proven using a χ^2 test. For the herds Mix, Sistema and Nueve, $P < 0,000$ and for the Secca herd $P = 0,031$. The higher P value for the Secca herd is probably due to the limited number of observations of that herd.

BodyAxisTotal * CranialSidesTotal Crosstabulation

			CranialSidesTotal		
			Together	Not Together	Total
BodyAxisTotal	In Line	Count	433	471	904
		% of Total	28.5%	31.0%	59.5%
	Not In Line	Count	147	469	616
		% of Total	9.7%	30.9%	40.5%
Total		Count	580	940	1520
		% of Total	38.2%	61.8%	100.0%

Table 3: Observed frequencies and percentages of total, of all combinations of lying with cranial sides together or not and lying with the body axis in line or not, from all the observations of all the observed herds together.

Lying with the cranial sides together is associated with an increased incidence of 25,6% of lying with their Body axis In Line, with a 95% reliability interval from 20,9 % till 30.3% for all the observations in total.

BodyAxisMix * CranialSidesMix Crosstabulation

			CranialSidesMix		
			Together	Not Together	Total
BodyAxisMix	In Line	Count	249	264	513
		% of Total	29.6%	31.4%	60.9%
	Not In Line	Count	81	248	329
		% of Total	9.6%	29.5%	39.1%
Total		Count	330	512	842
		% of Total	39.2%	60.8%	100.0%

Table 4: Observed frequencies and percentages of total, of all combinations of lying with cranial sides together or not and lying with the body axis in line or not, from all the observations of the “Mix“ herd.

Lying with the cranial sides together is associated with an increased incidence of 23,9% of lying with their Body axis In Line, with a 95% reliability interval from 17,6 % till 30,2% for the Mix herd.

BodyAxisSistema * CranialSidesSistema Crosstabulation

			CranialSidesSistema		
			Together	Not Together	Total
BodyAxisSistema	In Line	Count	101	119	220
		% of Total	27.8%	32.8%	60.6%
	Not In Line	Count	31	112	143
		% of Total	8.5%	30.9%	39.4%
Total	Total	Count	132	231	363
		% of Total	36.4%	63.6%	100.0%

Table 5: Observed frequencies and percentages of total, of all combinations of lying with cranial sides together or not and lying with the body axis in line or not, from all the observations of the “Sistema“ herd.

Lying with the cranial sides together is associated with an increased incidence of 25,0% of lying with their Body axis In Line, with a 95% reliability interval from 15,3 % till 34,7% for the Sistema herd.

BodyAxisNueve * CranialSidesNueve Crosstabulation

			CranialSidesNueve		
			Together	Not Together	Total
BodyAxisNueve	In Line	Count	47	50	97
		% of Total	26.3%	27.9%	54.2%
	Not In Line	Count	17	65	82
		% of Total	9.5%	36.3%	45.8%
Total	Total	Count	64	115	179
		% of Total	35.8%	64.2%	100.0%

Table 6: Observed frequencies and percentages of total, of all combinations of lying with cranial sides together or not and lying with the body axis in line or not, from all the observations of the “Nueve“ herd.

Lying with the cranial sides together is associated with an increased incidence of 29,9% of lying with their Body axis In Line, with a 95% reliability interval from 15,8 % till 44,0% for the Nueve herd.

BodyAxisSecca * CranialSidesSecca Crosstabulation

			CranialSidesSecca		
			Together	Not Together	Total
BodyAxisSecca	In Line	Count	36	38	74
		% of Total	26.5%	27.9%	54.4%
	Not In Line	Count	18	44	62
		% of Total	13.2%	32.4%	45.6%
Total		Count	54	82	136
		% of Total	39.7%	60.3%	100.0%

Table 7: Observed frequencies and percentages of total, of all combinations of lying with cranial sides together or not and lying with the body axis in line or not, from all the observations of the “Secca” herd.

Lying with the cranial sides together is associated with an increased incidence of 25,0% of lying with their Body axis In Line, with a 95% reliability interval from 15,3 % till 34,7% for the Secca herd.

There are small differences between the different herds in the association between Body Axis and Cranial Sides. These are possibly because the herds differ in size and were kept in different pastures. But overall the same tendency is observed in each of the herds.

5.4 Stepping forward or not when rising:

Within the mix group, 130 (71%) cows made a step forward during rising and 53 (29%) did not. 9 Times (75%) a cow of the Nueve herd did a step forward when rising and 3 times a cow (25%) did not do a step forward. In the Secca group 14 cows (77,8%) stepped forward when standing up and 4 (22,2%) did not. Within the Sistema herd 49 cows (80,3%) showed a step forward and (19,7%) 12 did not.

In total 274 times cows of the 5 herds were seen standing up. From those, 202 (73,7%) did a step forward and 72 (26,3%) did not.

Group	Step forward	No step forward	% Step forward	% No step forward
Mix	130	53	71%	29%
Nueve	9	3	75%	25%
Secca	14	4	77,8%	22,2%
Sistema	49	12	80,3%	19,7%
Total	202	72	73,7%	26,3%

Table 8: Observed risings of cows making a step forward or not and the calculated percentages for all the observed herds (Mix, Nueve, Secca and Sistema) and for all the herds together (Total).

To see if the proportion of cows making a step forward is statistically bigger than the proportion not making a step forward during rising, test 6 was conducted. For each test the null hypothesis is: The proportions in the population making a step forward when standing up or not are equal (50%). The alternative hypothesis is that proportions are unequal.

Herd	% stepping forward	N	Significant Yes/No	95% Confidence interval	
Mix	71,0	183	Yes P<0,00006	67,6	74,4
Nueve	75,0	12	No P<0,150		
Secca	77,8	18	Yes P<0,034	68,0	87,6
Sistema	80,3	61	Yes P<0,00006	75,2	85,4
Total	73,7	274	Yes P<0,00006	68,5	78,9

Table 9: Percentage of cows stepping forward when rising, the number of observations, the significance and confidence interval of the proportion of each herd and of all the groups together (Total).

Looking at the statistics of the total data, the null hypothesis can be rejected, because the observed cows who make a step forward (73,7%) is more than 50% of the total, with $P < 0,000$ and with a 95% confidence interval of 68,5% to 78,9 %.

All of the individual groups show that cows do make a step forward in 71,0 to 80,3 % of the cases. This is proven significant for each group, except the Nueve group. This is probably because there are not enough samples from the Nueve group to make it significant.

6 Discussion

The first aim of this study, to determine how cows lie in relation to each other in the pasture and evaluate if this behaviour is possible in the cubicle housing system, is met.

The observed cows lie in 61.8% of the cases with their cranial sides away from each other, which is impossible in the cubicle housing systems. Of the observed cows, 59.5% lie In Line, which is the way they are forced to lie in the cubicle housing system.

The presence of the correlation between “lying with the cranial sides together or not” and “lying with their body axis in line or not” within the total observations is proven ($P < 0,000$). And when combining the body axis and the cranial sides, it is possible to see what percentage of the observed pasture cows lie in a way that is possible in the cubicle housing systems namely with their Cranial Sides Together and In Line. This percentage is only 28.5% in pasture. In 71.5% of the observed cases cows lie in relation to each other in a way that is not possible in a cubicle housing system.

The results from the second part of this study, show that 73,7 % of the cows make a step forward when rising. The conclusion can thus be made that the neck rail impedes dairy cows in their behaviour.

All observations were done from a distance, and it was not possible to verify the observations from nearby, because the cows would be influenced by the observers when they approached to close. That is why a certain inaccuracy of the observations is possible.

Besides that, cows can lie down in countless different positions, but only a few different categories were used to record their behaviour in the present study. Sometimes cows were lying in between two different categories and one of them had to be chosen. There were some doubtful cases, but the decision was sometimes on one and the other time on the other category, so the mean error is probably small.

During this study, the observers ignored the individual cow-numbers, so it is not clear how many times each individual cow is included in the data. If some cows tend to lie more often than others, they might have a bigger influence on the data, than others.

And last, the investigators made a simplified description of the lying position behaviour between cows, by only mentioning the position between cows who lie closest to each other.

This study revealed that cows, that are on pasture during their entire life, would be hindered in their behaviour in free stall barns. It would be interesting to compare the data of the present study with the lying and getting up behaviour of cows that are kept in free stall barns when they are outside during the summer and see whether they have adapted their preferences to their restricted environment.

7 Conclusion

Because the observed cows lie more often with their cranial sides away from each other (61,8%; $p < 0.000$) than towards each other when lying freely in the pasture, it can be concluded that cows are not able to conduct their natural lying behaviour in modern cubicle housing systems, because in these housing systems, cows are forced to lie with their cranial sides together.

Besides that, only 28.5% of the observed cows lie in a way that is possible in the cubicle housing systems.

When cows do lie with their cranial sides together they lie 25,6% more often with their body axis In Line than when they do not lie with their cranial sides together. This means that when cows must be forced to position themselves with their cranial sides together, like in a cubicle housing system, it is best to do so with their body axis parallel to each other or in line.

In 73,7% of the cases cows make one or more steps forward during or directly after rising. This behaviour is impossible in the cubicle housing system, due to the neck rail of the free stall partitions or the sidewalls.

Because cows in a cubicle housing system can not lie in a natural position in relation to each other and are not able to stand up how they do in the pasture, the conclusion is that cubicle housing systems have their limitations to keep dairy cows, looking at their lying and standing up behaviour. This is an argument to search for other housing systems like the free range barns, where cows are free to choose their lying position and where they are not impeded when rising.

8 Acknowledgements

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