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ANALYSIS OF THE LYING AREA IN A BARN WITH THE USE OF A VIDEO RECORDING TECHNOLOGY

Marek Gaworski*

Department of Production Management and Engineering, Warsaw University of Life Sciences
*Contact details: ul. Nowoursynowska 164, 02-787 Warsaw, e-mail: marek_gaworski@sggw.pl

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ABSTRACT

The paper aimed at investigating influence of the period when cows were kept in a sand filled lying area onto the lying time and the animals's other behaviours if the bedding material was not supplemented in the lying stalls during the investigation period. Registration of the cows' behaviour in the investigated area was conducted continuously over 10 days, using the video recording technology. The investigation included two technological groups of dairy cows kept in a barn with a freestall maintenance system. A trend for reduced lying time of the cows over the investigated period was observed. The paper proposes an approach to analysis of the investigation results, which involved distinguishing blocked investigation days. Blocking the days within the continuous measurement of the cows' lying time allowed description of the dependent variable (cows' lying time over the investigated period) with a linear model characterised with a considerably higher value of the coefficient of determination in comparison to the option considering single days.

Introduction

Continuous improvement in cattle maintenance conditions is a common characteristic of contemporary dairy cattle production. Maintenance conditions determine the cattle's comfort in particular barn areas and in the cattle-run, which translates into the achieved production efficiency.

The importance associated with improvement of dairy cattle maintenance conditions, particularly in the lying area, is confirmed in numerous investigations which put significant emphasis on recognition of the influence of the selected structural characteristics of the lying stalls on the animals' behaviour and preferences.

Among the structural characteristics of lying stalls, analysed within the investigations, the quality and condition of bedding material is of key importance. The main reason underlying the undertaken investigations is the search for bedding materials ensuring the highest possible level of comfort to animals, decisive for the lying time length (Haley et al., 2000).

The detailed evaluation comprises various types of bedding materials, from concrete, matts and mattresses (Haley et al., 2001) to consumable materials such as hay, sawdust and sand (Tucker et al., 2003). An important criterion considered in the investigations is the condition of the bedding material, including humidity (Fregonesi et al., 2007b) and quantity of the bedding material (Drissler et al., 2005) in the area designated for the cows' rest.

Next to bedding materials, the investigations cover elements of the lying stall construction (in particular, in the freestall dairy cattle maintenance system), including above-neck railings (Tucker et al., 2005), stall divisions (Ruud and Bøe, 2011), as well as front limiting thresholds (Tucker et al., 2006), analysed in the context of dairy cattle comfort improvement.

A common denominator of numerous investigations concerning technical equipment of the dairy cattle lying area is assumption concerning the animals' preferences and behaviour as the evaluation criterion. Measurements of the time spent by animals in the lying position, number of entries into lying stalls, frequency of cows lying down and standing up as well as other forms of behaviour in the lying area characterised with certain structural and functional features give ground for drawing conclusions concerning the animals' reaction to particular tested technical solutions in the lying area.

Cows' preferences in the lying area and the analysis thereof provide a set of important information contributed to the know-how related to dairy cattle in connection with environmental factors (Nawrocki, 2009). The results of investigations covering cows' preferences in combination with specific technical and technological solutions in the barn can, therefore, be practically utilised for improving the animals' comfort and maintenance in livestock buildings.

Collecting detailed information connected with cows' behaviours and preferences in the lying area as well as in other barn areas encourages the use of properly selected investigation methods and apparatus. Both the methods and the apparatus used for monitoring of animals undergo continuous enhancement and evaluation (O'Driscoll et al., 2008; Ledgerwood et al., 2010), thus letting resolve scientific and research problems connected with the analysis of dairy cattle production in livestock buildings.

Investigation objective, scope and methodology

Keeping a herd of dairy cows in a barn with a freestall maintenance system may involve change in the condition of lying stall bedding material. While leaving the lying stalls, cows remove bedding material with their hoofs into a manure alley. Moreover, excrements remaining on the lying area surface frequently need to be removed by the staff, which involves removal of some of the bedding material into the manure alley. In consequence, as days pass by, the quantity of bedding material decreases which – if the material is added at longer intervals – may cause deteriorated rest conditions for animals in the lying area (Gaworski et al., 2003).

In the context of the problem related to the use of bedding materials in a barn, as mentioned above, the objective of the investigation was to determine influence of the time spent by cows in the sand-filled lying area on animals' lying time and other forms of behaviour when the bedding material was not supplemented in the lying stalls during the investigation period. Formulated as above, the investigation objective was related to raising a thesis that the level of sand covering the lying stalls reduces as days pass by and, therefore, animals' rest conditions in the lying area deteriorate. This was the underlying objective of the investigation, i.e. identification whether or not – over the days passing by and with a lowered level of sand – the cows' lying time during the day decreased, which may have unfavourable influence on their production indices.

The scope of investigation covered two selected pens in a freestall maintenance system barn, containing 12 lying stalls covered with sand as the bedding material. Each of the pens contained three rows of lying stalls (fig. 1). A single pen was occupied by the process group of 12 dairy cows.

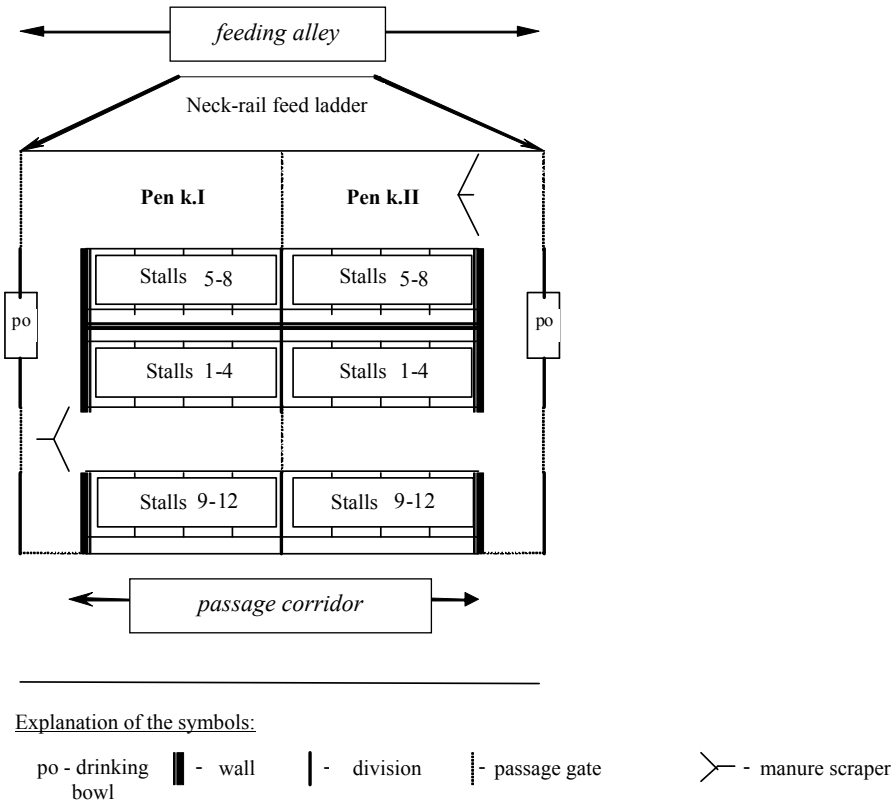

Figure 1. Schematic representation of rows with numbered lying stalls for dairy cows

In the first stage, the investigation methodology involved identification of cows included in the project. This was done using paint for writing subsequent letters of the alphabet on the cows' sides, which facilitated identification of particular animals during the recording thereof and, subsequently, playback of the video material. A set consisting of cameras (one for each pen), Panasonic AG-6540 single-picture video, Panasonic WJ-FS 216 multiplexer and a monitor used in the project for ongoing viewing of recorded cows as well as playback of the video material to be used in detailed analyses. Recording of the cows' behaviour in the lying area was being conducted continuously for 10 days.

Before commencement of recording, bedding material in the lying stalls was prepared so that the level of the sand was equal with the level of the rear curb separating the stall from the manure alley, which corresponded to the industrial practice related to filling the pan constituting the lying stall bottom with sand.

The following dairy cows' behaviours were considered during detailed observations of the recorded video material:

– lying in the lying stalls,
– standing with front legs on the bedding material and with rear legs in the manure alley,
– standing with four legs on the bedding material.

Throughout the investigation period, the same technological groups of dairy cows were kept in particular pens. The cows were not removed from the pens for veterinary or other procedures, but they only left their place twice a day for the time needed for miliking in the milking hall.

During playback, the recorded video material was divided into 10-minute sections used for reading the analysed cows' behaviours, including lying as well as standing with two and four legs on the bedding material of particular lying stalls. Cows' behaviours identified based on the recorded video material were recorded in an Excel form. Identification of cows which were lying, standing with two or four legs during subsequent periods of time was entered into particular fields of the form identifying the lying stalls. If a lying stall was not occupied by a cow during the given period, the field was left blank.

The investigation was conducted in a barn with a freestall dairy cow maintenance system, in a farm located on the western coast of Canada.

Investigation results and discussion

From among observation results collected in Excel spreadsheet, data concerning the cows' lying time were selected for detailed analysis of the cows' behaviours and preferences. For each day of analysis, the time during which particular stalls in a given pen were occupied by cows in the lying position was summed up. Results concerning the total time of lying in the stalls, concerning particular days (from day 1 to day 10) are presented in tables 1 and 2 for pens k.I and k.II, respectively. This form of results presentation is referred to in tables 1 and 2 as "Analysis option 1". Moreover, an extension in "Analysis option 2" and "Analysis option 3" is proposed based on the collected research results, as presented in tables 1 and 2.

Table 1
Lying time of 12 dairy cows in the investigated pen k.I including combined periods

Analysis option 1		Analysis option 2		Analysis option 3	
Day	Lying time (min·24h^{-1})	Combined periods (A)	Lying time (min·48h^{-1})	Combined periods (B)	Lying time (min·24h^{-1})
1	8,620	1. (days 1-2)	18,250	I (days 1-5)	8,984
2	9,630				
3	8,710	2. (days 3-4)	17,850		
4	9,140				
5	8,820	3. (days 5-6)	18,050		
6	9,230			II (days 6-10)	8,744
7	8,810	4. (days 7-8)	17,120		
8	8,310				
9	8,590	5. (days 9-10)	17,370		
10	8,780				

Table 2
Lying time of 12 dairy cows in the investigated pen k.II including combined periods

Analysis option 1		Analysis option 2		Analysis option 3	
Day	Lying time (min·24h^{-1})	Combined periods (A)	Lying time (min·48h^{-1})	Combined periods (B)	Lying time (min·24h^{-1})
1	9,270	1. (days 1-2)	18,700	I (days 1-5)	9,052
2	9,430				
3	9,480	2. (days 3-4)	18,440		
4	8,960				
5	8,120	3. (days 5-6)	17,270		
6	9,150			II (days 6-10)	8,906
7	9,280	4. (periods 7-8)	17,680		
8	8,400				
9	9,080	5. (days 9-10)	17,700		
10	8,620				

Within “Analysis option 2”, the investigation time was divided into five time intervals, each including two days. The lying time covered by combined investigation periods (A) was determined based on the sum of the following periods during the investigation: 1-2, 3-4, 5-6, 7-8 and 9-10.

The distinctive characteristic of “Analysis option 3” was the division of the investigation period into two parts, considering – respectively – the first five and the last five days, during which observation of the animals was conducted in the lying areas of pens k.I and

k.II. In the case of distinguished five-day periods, referred to as combined periods (B), the average lying time was determined for one day, both in pen k.I (tab. 1) and in pen k.II (tab. 2).

Based on the figures for the two investigated pens, analysis of variance for the cumulative lying time of 12 dairy cows in relation to s pen was conducted using Statistica v.10 software. Analysis reults are presented in table 3.

Moreover, analysis of variance for the cumulative lying time of 12 dairy cows in relation to pen, including data for combined periods (A) for the two investigated pens was conducted. Analysis results are presented in table 4.

Table 3
Analysis of variance for cumulative lying time of 12 dairy cows in relation to pen

	Sum of quadrants	Degrees of liberty	Average quadrants	Fisher-Snedecor F statistics	Critical significance level p
Absolute term	1.591863E+09	1	1.591863E+09	9109.29	0.0000
Pen	6.612500E+04	1	6.612500E+04	0.38	0.5462
Error	3.145530E+06	18	1.747517E+05		

Table 4
Analysis of variance for cumulative lying time of 12 dairy cows in relation to pen, including data for combined periods

	Sum of quadrants	Degrees of freedom	Average quadrants	Fisher-Snedecor F statistics	Critical significance level p
Absolute term	3.183726E+09	1	3.183726E+09	11127.24	0.0000
Pen	1.322500E+05	1	1.322500E+05	0.46	0.5158
Error	2.288960E+06	8	2.861200E+05		

One of the factors inspiring the proposition of "Analysis option 2" and "Analysis option 3" was the course of changes in the total lying time of cows in the investigated pens over the 10 subsequent days (fig. 2). A comparison of data from particular days and pens allows determination of a random character of the investigated value (lying time), analysed over particular days. Therefore, to expand the analysis, figure 3 presents changes in the total lying time of cows in pens k.I and k.II over 5 combined investigation periods.

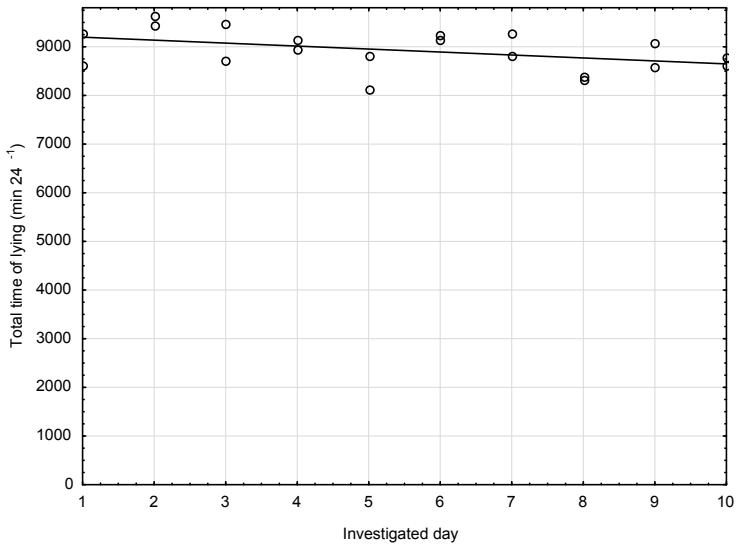

Figure 2. Changes of total lying time of dairy cows in k.I and k.II pens for 10 following days

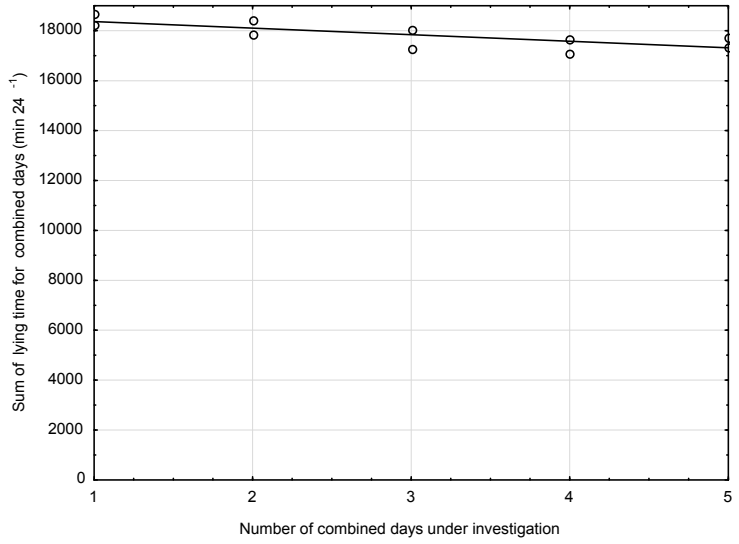

Figure 3. Changes of total lying time of dairy cows in k.I and k.II pens for 5 combined periods

Analysis of regression of the dependent variable, i.e. total lying time of dairy cows depending on a day was performed for data from investigated pens k.I and k.II. Summary of the analysis is presented in table 5.

Table 5
Analysis of regression of dependent variable, i.e. total lying time of dairy cows depending on day

Source of variability	Regression coefficient	Standard error of regression coefficient	t-Student test	Critical significance level p
Absolute term	9,257.0	183.5	50.45	0.0000
Day	-61.0	29.6	-2.06	0.0539

Analysis of regression of the dependent variable, i.e. total lying time of dairy cows depending on combined periods was also conducted considering data for pens k.I and k.II. Summary of the analysis is presented in table 6.

Table 6
Analysis of regression of dependent variable, i.e. total lying time of dairy cows depending on combined periods

Source of variability	Regression coefficient	Standard error of regression coefficient	t-Student test	Critical significance level p
Absolute term	18,630.5	267.8	69.57	0.0000
Combined periods	-262.5	80.7	-3.25	0.0117

A relation between combined investigation days may be presented using a linear function with the critical significance level of $p = 0.0117$ (tab. 6). Combining of the days during the continuous time of measurement of the cows' lying time allowed determination of the dependent variable (cows' lying time during the investigated period) with a linear model characterised with a significantly higher value of the determination coefficient (R^2=0.569) as compared with the option considering individual days (R^2=0.191).

The trend related to decreasing lying time of cows in the pen during the investigation period was confirmed by "Analysis option 3" (tables 1 and 2), considering two time periods, i.e. days 1-5 and days 6-10. The comparison of the average daily lying time in pen k.I allows statement that the lying time during the second period (days 6-10) was shorter as compared with the corresponding time determined during the first period (days 1-5) by 240 min·day^{-1}, i.e. app. 2.67%. On the other hand, in the case of pen k.II, the lying time during the second period (days 6-10) was shorter as compared to the corresponding time determined during the first period (days 1-5) by 146 min·day^{-1}, i.e. app. 1.61%.

In reference to the assumption made in the paper, one may state that results of the conducted investigations suggested the possibile problem of reduced cows' lying time over subsequent days spent by the animals in the pen with the freestall lying area. Reduction of the lying time over the investigated period of 10 days may result from the lowering level of sand in the lying stalls, as indicated by the investigations conducted by Drissler et al. (2005). The lowering sand level in the pan constituting the lying stall causes that the inner surface of the rear stall curb is uncovered. As the inner surface of the rear stall threshold is sloped, along with the lowering level of sand, the active length of the stall where a cow may lie is reduced. This involves numerous kinds of discomfort experienced by animals, i.e. both as the reduced comfort of lying and a growing risk of abrasion of hair on the rear legs of an animal as a result of contact with the side surface of the curb (Mowbray et al., 2003).

A condition of the bedding material in the stall, including that resulting from the quantity of sand, is one of but not the only determinant of the cows' lying time. The results of detailed investigations cited in the literature indicate the possibility of seasonal differences within the lying time (Uzal Seyfi, 2013), as well as the influence of such factors as location of lying stalls within the pen (Gaworski et al., 2003; Wagner-Storch et al., 2003), number of animals in the group (Fregonesi et al., 2007a), environmental and other conditions on the lying time. The multitude of factors determines the complexity of undertaken investigations and the need for further development of knowledge related to factors influencing behaviour of cows in the barn lying area, including selection of investigation methods including the use of video recording.

Conclusions

The conducted investigation demonstrated a trend for reduction in the cows' lying time over the investigated period of 10 days during which sand was not added to the lying stalls. Possible extension of the investigation period to more than ten days might justify a claim on the impact of keeping cows in the pen without supplementing the bedding material (sand) onto the lying time.

The proposed method of investigation of the results of the analysis, which involved distinguishing of the blocked investigation days, allowed logical shaping of the interrelation between the lying time and subsequent periods of time and its presentation with the use of linear regression.

Investigations related to changes in cows' lying time constitute a premise for undertaking reasonable decisions on supplementing the bedding material, including sand, which needs to be extended in further detailed analyses.

References

Drissler, M.; Gaworski, M.; Tucker, C.B.; Weary, D.M. (2005). Freestall maintenance: Effects on lying behavior of dairy cattle. *Journal of Dairy Science, 88*, 2381-2387.

Fregonesi, J.A.; Tucker, C.B.; Weary, D.M. (2007a). Overstocking reduces lying time in dairy cows. *Journal of Dairy Science 90*, 3349-3354.

Fregonesi, J.A.; Veira, D.M.; von Keyserlingk, M.A.G.; Weary, D.M. (2007b). Effects of bedding quality on lying behaviour of dairy cows. *Journal of Dairy Science,* 90, 5468-5472.

Gaworski, M.A.; Tucker, C.B.; Weary, D.M.; Swift, M.L. (2003). Effects of stall design on dairy cattle behaviour. Fifth International Dairy Housing Proceedings of the 29-31 January 2003 Conference, *ASAE*, Fort Worth, Texas, USA, 139-146.

Haley, D.B.; de Passillé, A.M.; Rushen, J. (2001). Assessing cow comfort: Effects of two floor types and two tie stall designs on the behaviour of lactating dairy cows. *Applied Animal Behaviour Science, 71*, 105-117.

Haley, D.B.; Rushen, J.; de Passillé, A.M. (2000). Behavioural indicators of cow comfort: Activity and resting behaviour of dairy cows in two types of housing. *Canadian Journal of Animal Science, 80*, 257-263.

Ledgerwood, D.N.; Winckler, C.; Tucker, C.B. (2010). Evaluation of data loggers, sampling intervals, and editing techniques for measuring the lying behavior of dairy cattle. *Journal of Dairy Science, 93*, 5129-5139.

Mowbray, L.; Vittie, T.; Weary, D.M. (2003). *Hock lesions and free-stall design: Effects of stall surface*. Fifth International Dairy Housing Proceedings of the 29-31 January 2003 Conference, *ASAE*, Fort Worth, Texas, USA, 288-295.

Nawrocki, L. (2009). *Technika a dobrostan bydła*. Opole, OW Politechnika Opolska, 222. ISBN 978-83-60691-54-0.

O'Driscoll, K.; Boyle, L.; Hanlon, A. (2008). A brief note on the validation of a system for recording lying behaviour in dairy cows. *Applied Animal Behaviour Science, 111*, 195-200.

Ruud, L.E.; Bøe, K.E. (2011). Flexible and fixed partitions in freestalls – Effects on lying behavior and cow preference. *Journal of Dairy Science, 94*, 4856-4862.

Tucker, C.B.; Weary, D.M.; Fraser, D. (2003). Effects of three types of free-stall surfaces on preferences and stall usage by dairy cows. *Journal of Dairy Science, 86*, 521-529.

Tucker, C.B.; Weary, D.M.; Fraser, D. (2005). Influence of neck-rail placement on free-stall preference, use, and cleanliness. *Journal of Dairy Science, 88*, 2730-2737.

Tucker, C.B.; Zdanowicz, G.; Weary, D.M. (2006). Brisket boards reduce freestall use. *Journal of Dairy Science 89*, 2603-2607.

Uzal Seyfi, S. (2013). Seasonal variation of the lying and standing behavior indexes of dairy cattle at different daily time periods in free-stall housing. *Animal Science Journal, 84*, 708-717.

Wagner-Storch, A.M.; Palmer, R.W.; Kammel, D.W. (2003). Factors affecting stall use for different freestall bases. *Journal of Dairy Science, 86*, 2253-2266.

WYKORZYSTANIE TECHNIKI FILMOWEJ W BADANIACH STREFY LEGOWISKOWEJ W OBORZE

Streszczenie. Celem pracy były badania wpływu okresu przebywania krów w strefie legowiskowej z piaskiem na czas leżenia i inne formy zachowań zwierząt w sytuacji, gdy materiał podłoża nie był w boksach legowiskowych uzupełniany w okresie badań. Rejestrację zachowania krów w badanej strefie prowadzono w sposób ciągły w okresie 10 dni z wykorzystaniem techniki filmowej. Zakresem badań objęto dwie grupy technologiczne krów mlecznych w oborze z wolnostanowiskowym systemem utrzymania. Wskazano na tendencję zmniejszania czasu leżenia krów w badanym okresie. Zaproponowano metodę podejścia do analizy wyników badań, uwzględniającą wyodrębnienie zblokowanych dób badań. Zblokowanie dób w pomiarze ciągłym czasu leżenia krów przełożyło się na możliwość opisania zmiennej zależnej (czasu leżenia krów w rozpatrywanym okresie) modelem liniowym wyróżniającym się znacznie wyższą wartością współczynnika determinacji w porównaniu z opcją uwzględniającą pojedyncze doby.

Słowa kluczowe: krowa, boks legowiskowy, czas leżenia, rejestracja filmowa