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Effect of management practices and free-stall construction on losses of sand used as a bedding material for dairy cows – pilot study

MAREK GAWORSKI[1], ÁGUIDA GARRETH FERRAZ ROCHA[2]
[1]Department of Production Management and Engineering, Warsaw University of Life Sciences – SGGW
[2]Faculty of Veterinary Medicine and Zootechny, University Federal of Uberlandia, Brazil

Abstract: *Effect of management practices and free-stall construction on losses of sand used as a bedding material for dairy cows – pilot study*. The aim of the paper was to determine how some management practices, i.e. mechanical sand spreading on the stalls, affected possible losses of the bedding material. Measurements of sand level before and after machine spreading on 24 lying stalls were carried out in the barn with cows kept in a free stall system. Results of investigation showed considerable difference between two operators involved in the sand spreading on the lying stalls, especially different precision of spreader operators in terms of sand management in the lying area.

Key words: barn, cow, dairy, sand bedding, sand level

INTRODUCTION

Cow comfort as part of animal welfare is one of the key factors determining effectiveness of farm dairy production [von Keyserlingk et al. 2009]. Such comfort can be created in many areas of the barn related to cow herd handling. Apart from the daily time budget for lactating dairy cows [Grant 2007], the lying area plays the most important role. Therefore, it is necessary to create excellent comfort conditions in this place.

There are many details which determine the evaluation of the lying area in the barns with various keeping systems. Nordlund and Cook [2003] suggest that the lying surface is the most important component of free-stall design. It has been confirmed by investigations involving the development of different materials used as lying surface in order to compare them in terms of such aspects as cow preferences, lying behaviour and hygiene [Herlin 1997]. The lying behaviour of dairy cows is strongly dependent on bedding quality [Fregonesi et al. 2007]. Cows prefer lying surfaces with more bedding, and they tend to spend more time lying down in well bedded stalls than in the places with poor bedding [Tucker et al. 2003, Wagner-Storch et al. 2003]. The amount of bedding used on the stall surface affects the response of the cow. Drissler et al. [2005] documented how declines in deep-bedded and unmaintained stalls with sand as a bedding material showed a dramatic effect on stall usage; the lying time decreased by about 10 min/day with each cm of reduction in sand bedding.

Understanding sand properties and proper sand management is critical to the selection and successful use of sand as a dairy bedding material [Timms 2015]. In order to successfully use and manage sand as a bedding material for cows, it is necessary to consider the stall design [Gaworski et al. 2003]. There are many stall designs for barns with a free-stall system, and accordingly, sand management practices should be adjusted to the stall design details. Thus, the aim of the study was to determine how some management practices, i.e. mechanical sand spreading on the stalls, affected possible losses of the bedding material.

MATERIAL AND METHODS

The investigations were conducted at the University of British Columbia's Dairy Education and Research Centre in Agassiz, British Columbia, Canada, where sand is a bedding material in the barns. The investigated, naturally ventilated (with curtained sidewalls) wooden frame barn consisted of 288 free stalls divided into smaller units, i.e. pens with 12 stalls each. The lying stalls in each individual pen were arranged in three rows, two rows facing one another and the back row facing a cement wall (Fig. 1). The pens were equipped with stalls divided

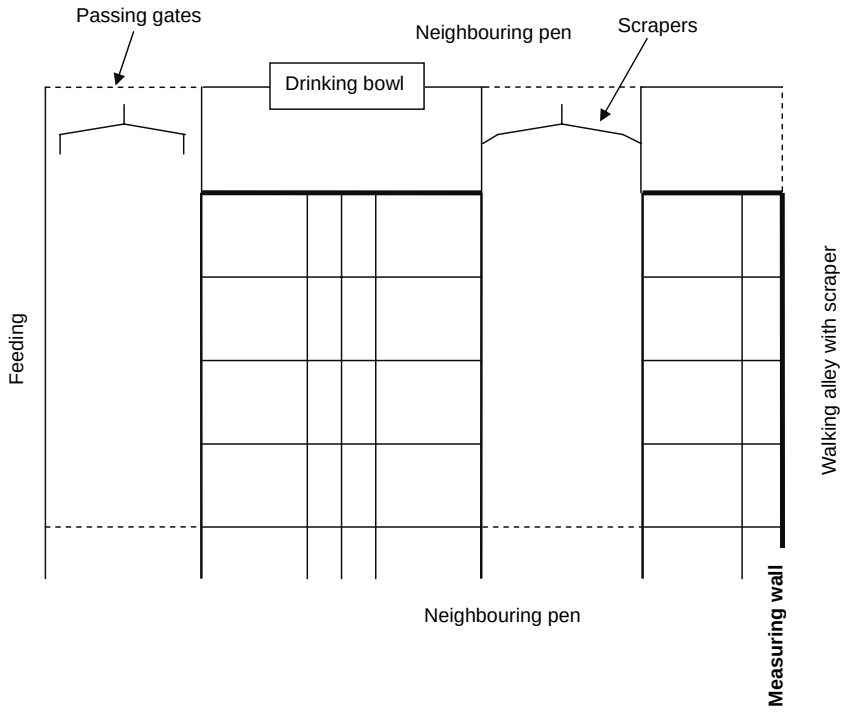

FIGURE 1. Diagram of one of the pens with the wall where measurements of sand level changes were carried out

by Dutch-style partitions. One stall at each row was bounded by cement wall.

The lying stalls in the barn were refilled with new sand every fortnight. A spreader attached to a tractor unit, with a three-point linkage, was used to spread sand on the lying stalls in the barn. During sand spreading, the spreader outlet was at a height of 1.2 m above the ground, and the speed of the tractor amounted to 0.6 ±0.2 m/s. Sand was spread during forward and reverse gear movements of the tractor.

In order to spread sand on the stalls located in three rows, the tractor with the device (the spreader) had to move along two scraper alleys (Fig. 1), with wheels near the stall rear curb. During sand spreading, the scrapers were stopped at such a position as to enable the tractor to move along the scraper alleys without any hindrance. At the time of refilling the stalls with sand, the cows were separated in each pen with chains isolating the part of the pen where the cows were located.

In order to determine how some management practices, i.e. mechanical sand spreading on the stalls, affected possible losses of the bedding material, measurements were carried out on the wall dividing the back row (facing the cement wall) and the walking alley with scraper (Fig. 1). It means that research data were only collected from four stalls in each pen with lying stalls.

First, before spreading new sand on the stalls, the distance between the top part of the wall and the level of the sand at the wall was measured (Fig. 2). In order to measure the distance, a timber board was placed on the top of the wall. The bottom edge of the board had 12 reference points, marked every 10 cm along the board. The distance between each reference point (located at the same level as the top of the wall) and the sand at the wall was measured. The length of the removable timber board, including 12 reference points, was 110 cm. This dimension was similar to the width of each lying stall. For each stall, measurements

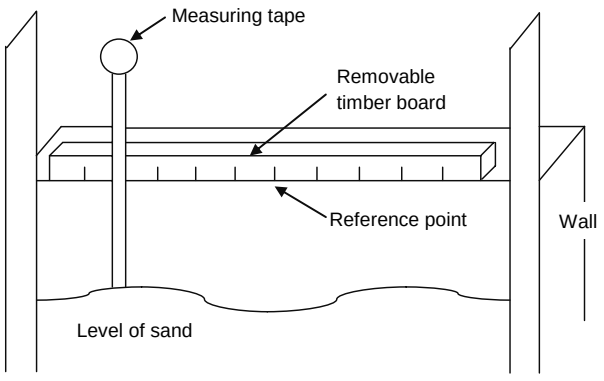

FIGURE 2. Diagram of sand level measurements

of the distance between the aforementioned 12 reference points and the sand level at the wall were carried out. The measuring data from 48 stalls were collected before and after refilling the stalls with new sand. Additionally, measurements from 24 stalls were also collected before the sand refill. Two persons (operators – tractor drivers) were individually involved in activities related to sand spreading on the stalls. Each operator was responsible for spreading new sand on 24 stalls where the measurements were carried out. For the purpose of further analyses, the operators were defined by letters "A" and "B".

Measuring tape was used in order to measure the distance between the reference points and the sand level at the wall. The investigators used typical flexible measuring tape with a stiffening function to facilitate the measurements. The accuracy of the measurements was 0.5 cm.

A statistical analysis of collected data was conducted using the Statistica v.12 software.

RESULTS AND DISCUSSION

The results of measurements were collected in order to compare the level of the sand at the cement wall before and after mechanical spreading of new sand on the lying stalls. The difference between the level of the sand at the cement wall before and after the spreading of new sand on the lying stalls was the main criterion of comparison used to determine hypothetical sand losses. The second criterion of comparison was related to the operator (driver) of the vehicle, responsible for sand spreading. Each of the two operators spread sand on 24 lying stalls divided into six pens. On the basis of the data collected from six pens (I–VI), for operator "A", the sand level before the spreading was (mean ±SD) 30.5 ±3.7 cm, and after the spreading – 29.8 ±3.7 cm. Due to the fact that the results indicate mean distances between the reference points at the top of the timber board and the sand level at the wall, we may conclude that as a result of spreading, the sand level increased by 0.7 cm.

For operator "B", the sand level before the spreading was (mean ±SD) 29.4 ±6.6 cm, and after the spreading only 24.3 ±6.4 cm. The comparison of the results showed a 5.1 cm increase in the sand level after the spreading of the bedding material in six pens (VII–XII) by operator "B".

The results of detailed comparison of the sand level before and after the spreading in individual pens were presented in Figures 3 and 4 for the first (I–VI) and the second (VII–XII) group of pens respectively. Operator "A" was responsible for spreading the sand in the first group of pens, and operator "B" performed the same task in the second group.

The results of variance analysis were presented in Table 1. The following parameters were included in the analysis: stage of measurements (options: before

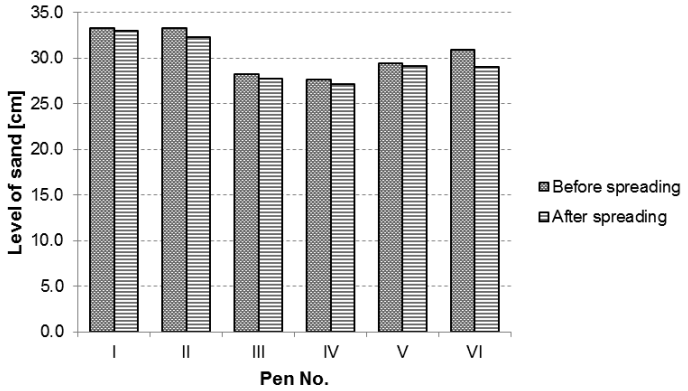

FIGURE 3. Sand level changes measured at the front wall in six pens (I–VI), before and after sand spreading by operator "A"

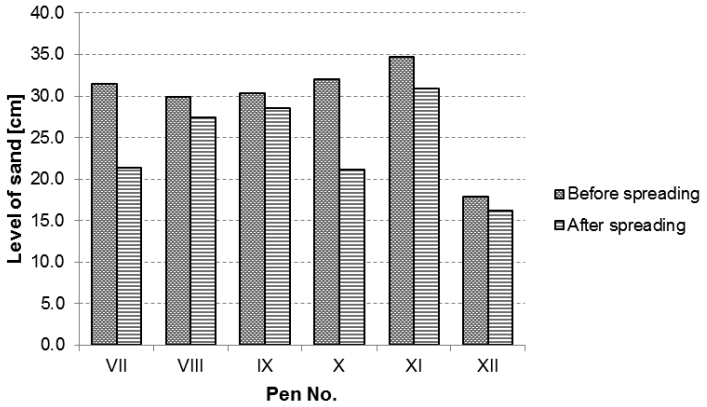

FIGURE 4. Sand level changes measured at the front wall in six pens (VII–XII), before and after sand spreading by operator "B"

TABLE 1. Variance analysis of selected parameters included in the investigation

Effect	*SS*	*df*	*MS*	*F*	*p*
Stage	205.63	1	205.63	26.80	0.000002
Pen	1623.72	11	147.61	19.24	0.000000
Stall	4.37	3	1.46	0.19	0.902984
Error	613.73	80	7.67	–	–

and after sand spreading), pen and stall. The level of the sand was a dependent variable in the analysis.

In order to verify the effects of the work of operators "A" and "B", who spread the sand on the lying stalls, the difference in the sand level was calculated for the stage before and after the spreading in each stall and pen. The result of the variance analysis related to the operators and the difference in the sand level were presented in Table 2.

TABLE 2. Variance analysis including evaluated operators

Effect	*SS*	*df*	*MS*	*F*	*p*
Operator	227.14	1	227.14	19.20	0.000068
Error	544.11	46	11.83	–	–

The results of the variance analysis showed a significant (p <0.05) difference between the effects of the work of the operators responsible for spreading sand on the lying stalls.

The results of the investigation show a considerable difference between the two operators involved in the sand spreading on the lying stalls (Fig. 5). Greater differences between the sand level (measured on the front wall) before and after the spreading are attributable to higher possible losses of sand when spreading on stalls without a front wall. Such lying stalls with open front space are also used in the farm. Therefore, the next step of the investigations could involve measurements of the amount of sand lost (in kg) during the sand spreading.

Measurements and observations indicated different precision of spreader operators related to sand management in the lying area. The device provides for some adjustments in the range of spreading. Thus, when combined with proper operator skills, there is a possibility to carry out such activities in the barn without or with minimal losses.

The investigations showed that the issue of sand in the barn could be considered more extensively than merely in terms of the use and the amount of the sand used on the stalls as an effect of animal (cow) activities and preferences. The issue of sand use in dairy production does not only concern animals [Fregonesi et al. 2007] but also the staff working in the barn, who decide about the frequency of sand filling [Drissler et al. 2005] as well as the precision of sand spreading.

Improving some control systems in terms of technological processes of

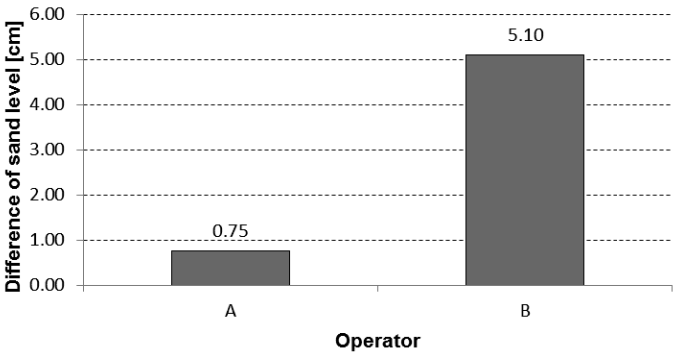

FIGURE 5. Comparison of sand level differences (before and after sand spreading) for two evaluated operators: “A” and “B”

milking, differential feeding and services in the dairy farming, based on precision technologies and technological means, is the most promising manner of technical development in dairy farming [Shevchenko and Aliev 2013]. The problem of evaluation of management practices within the cow keeping system has become a crucial part of assessment of the use of the technical potential in dairy production [Gaworski and Dumas 2012].

CONCLUSIONS

The investigations in the barn with a free--stall system were developed in order to identify some additional aspects related to the effectiveness of use of sand as a bedding materisal for dairy cattle. The comparison of the level of sand spread in the front part of the lying stalls showed a significant difference between operator management practices, which may determine the possible losses of sand in the case of a lying stall without a front wall. The assessment of sand management in the barn where sand is used as a bedding material should incorporate animal preferences, as well as operator skills and practices.

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Streszczenie: *Wpływ zasad użytkowania sprzętu i konstrukcji stanowisk legowiskowych na straty piasku jako materiału podłoża dla krów mlecznych – badania wstępne*. Celem pracy było określenie, w jaki sposób pewne praktyczne zasady postępowania, tj. mechaniczne rozprowadzanie piasku na stanowiskach legowiskowych dla krów mlecznych, mogą wpływać na potencjalne straty materiału podłoża. Przeprowadzono pomiary poziomu piasku przed maszynowym uzupełnieniem i po nim na 24 stanowiskach legowiskowych. Badania wykonano w oborze z wolnostanowiskowym systemem utrzymania krów mlecznych. Wyniki badań wskazały na znaczne różnice między dwoma operatorami agregatu maszynowego (ciągnik + rozrzutnik piasku), realizującymi zadanie związane z uzupełnianiem piasku na stanowiskach legowiskowych w oborze. Stwierdzone różnice dotyczyły szczególnie dokładności w rozprowadzaniu piasku w obszarze legowiskowym obory.

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Author's address:
Marek Gaworski
Wydział Inżynierii Produkcji SGGW
Katedra Organizacji i Inżynierii Produkcji
02-787 Warszawa, ul. Nowoursynowska 164
Poland
e-mail: marek_gaworski@sggw.pl