Influence of cow herd structure onto milk yield factors at the milking parlour

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Abstract: *Influence of cow herd structure onto milk yield factors at the milking parlour.* The aim of the study was to analyse the movement of cattle in the area of a free-stall barn preceding entry into the milking parlour, considering the herd differentiation criterion. Herd differentiation considered cows which, at the stage of launching the milking parlour at a new barn had been previously kept in a free-stall system and cows kept in the tied system. The investigation proved that with an increased share of cows previously kept in the free-stall system in the group entering the milking parlour, the time of entry into the milking parlour was reduced. Moreover, attention was paid to the growth trend related to milk yield per cow along with a growing share of cows from the free-stall system.

Key words: milking parlour, cow, milk, herd, maintenance system

INTRODUCTION

At the time of milk production and milk cow breeding concentration, increased numbers of breeders are faced with the challenge of building a new livestock building – the barn. To ensure profitability of breeding and efficient milking, ultimate comfort and welfare must be assured to the animals. This is why many agricultural producers decide to build a free-stall building.

Naturally, cows kept in the free-stall system must be in motion and move within the barn or, possibly, additional surrounding walking path [Broom 1986, Blandford 2006]. The motion should not be forced by people taking care of the cattle, but ought to result from natural needs of milk cows, i.e. be determined by such factors as hunger, thirst or need to be milked [Breuer et al. 2000].

At free-stall barns, milking is performed mainly at milking parlours. Before milking, cows are chased away to a special compartment referred to as the milking parlour. The main differences which may occur among milking parlours include the number of stalls, cow position and the method of attaching milking cups [Kupczyk et al. 2003]. Yet, before the cows enter the milking stalls, they must be led to the designated part of the barn, which is called the waiting area. Separation of the waiting area is indispensable, so that the cows which have already been milked are not mixed with non-milked cows. The area designated per one cow at the waiting area ought to be about 2 m^2. The reason underlying this space allocation is that it lets the cows enter the milking stalls as quickly as possible [Nawrocki 2008]. A very important aspect is the flooring surface at the milking parlour and the waiting area – it must guarantee very good grip, but also be easy to clean [Neja et al. 2006].

The milking system made up by the milking parlour and the waiting area ought to be very efficient. One of the elements decisive for its efficiency are the cows themselves. A herd of cows entering the milking parlour from the waiting area constitutes a group of animals differing in terms of height, weight, behaviour and other characteristics. This differentiation is an inspiration to undertake investigations aimed at deeper analysis of factors connected with efficient movement of cows from the waiting area to the milking parlour.

The aim of the study was to analyse movement of the cattle in the area of a free-stall barn which precedes entry of cows into the milking parlour, taking into consideration the herd differentiation criterion. Herd differentiation considered cows which, at the stage of launching the milking parlour at a new barn had been previously kept in a free-stall system and cows kept in the tied system.

MATERIAL AND METHOD

The agricultural farm where the investigation was conducted is located in the Mazovian province, Sokołów county, Sokołów Podlaski borough, in the village of Przywózki. The farm has 60 ha of land where the following plants are cultivated: corn for cattle silage (25 ha), pastures on arable land (20 ha) and mixed cereals (15 ha) to be used as cattle fodder.

Approximately 100 cows are kept at the farm, including 60 milk cows, 30 heifers to be used for herd renovation and enlargement, as well as 10 fattened cows. Depending on age, heifers are kept in the free-stall system on deep bedding or crates, whereas fattened cows are kept tied. Milk cows stay in a free-stall barn constructed in 2015, equipped with a 2×7 herringbone milking parlour where the milking stalls are arranged at the angle of 30° towards the milk canal.

Thanks to mechanisation of many kinds of work, the herd is handled by three people. Average milk yield of cows is about 8,000 kg over 305 days of lactation. Approximately three portions of semen are used for effective fertilisation of a cow, but in case of heifers the number of portions is lower (1.5 portion on average). On average, cows at the farm are used over four lactation cycles.

During the investigation period, as milk production was launched at a new barn, fodder was served manually to the fodder table. The cows received fodder twice a day, in the following sequence: hay silage, corn silage and fodder produced at the farm. Ingredients of the fodder included: cereal mixture, triticale, soy pellets, canola pellets, buffer, sodium bicarbonate and fodder chalk. Moreover, the cows obtained fodder characterised with 18% protein content, served at fodder stations, at respective serving sizes for their milk yield and lactation stage.

The newly constructed barn where the investigation was carried out is erected on a 35 m wide, 39 m long and 9.5 m high steel structure. The barn is divided into two symmetrical parts by means of a 5 m wide fodder table. Structure of the area designated for milk cows includes two walking corridors and three rows of lying stalls, including two "head to head" rows and a single row of lying stalls situated by the wall of the barn. Walking corridors nearby the fodder table and between the rows of lying stalls

are 4 and 3 m wide, respectively. The walking corridors are constructed from concrete grates, and the lying stalls are covered with foam mats. The section of the barn in which cows satisfy their vital functions connected with consumption of fodder and relaxation is presented in Figure 1.

Cameras with a decoder enabling the recording and replaying of image were installed at the barn equipped with the milking parlour. In connection with the investigation, some of the cows were marked. The material recorded by the cameras was analysed in terms of time spent by animals on passing from the lying and eating part of the barn into the building part performing the function of the waiting area, as well as time of entry into the milking parlour from the waiting area.

The time of entry from the waiting area into the milking parlour was analysed for three groups of milk cows of 14 animals each, i.e. the same number as the number of stalls in both rows of the milking parlour. The time of entry into the milking parlour was measured from entry of the first cow until the last cow took her place at a stall in one of the rows of the milking parlour. The time of occupying the stalls at the milking parlour by particular groups of cows was measured with the accuracy of one minute.

Measurements of the time of entry into the milking parlour were performed both at the time of morning and evening milking. The investigation was conducted for three consecutive days, immediately after launching the new milking parlour at the new barn constructed at the farm in question.

Particular groups of animals included in the investigation differed with respect to share of cows from two categories. The first category included cows which had been milked in the milking parlour before, whereas the second one included cows which had been kept in inventory buildings with a tied keeping system before being moved to the free-stall barn.
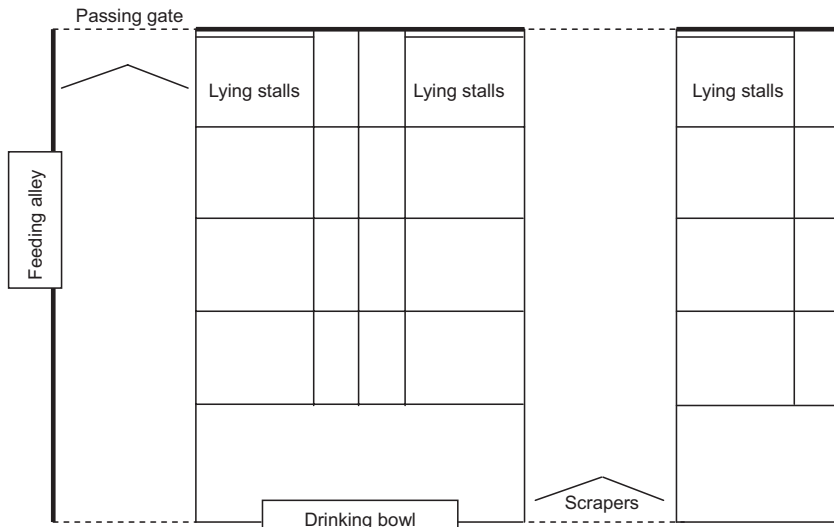

FIGURE 1. Diagram of the barn section designated to eating and relaxation of cows (own materials)

This composition of the analysed group was expected to contribute to answering the question concerning influence of the previous keeping method on cows' behaviour while proceeding to the stalls at the milking parlour.

RESULTS AND DISCUSSION

Detailed analysis of the investigation results considered the following data: time of entry of particular groups of cows from the waiting area into the milking parlour, milking time of particular groups, amount of milk obtained (per cow) and structure of milked animals in each group.

The structure of each of the milked groups considered the relation between the number of cows kept in the free-stall system and in the tied system before the experiment.

Collected investigation results were used for graphical illustration of the relations within the set of milking factors in the milk production system of the analysed farm.

During analysis of the investigation results, an attempt was undertaken to relate the time needed for entry of a group of cows into the milking parlour with the milking time of the given group of animals. The relation is presented in Figure 2. Along with prolonged time of entry of the group of cows from the waiting area into the milking parlour, growth in the milking time of the given group of milk cows was observed.

In subsequent figures, the basis for analysis was the group structure resulting from the share of cows kept in barns with the free-stall system and in barns with the tied system immediately before commencement of the investigation. The said structure was expressed in an index reflecting the ratio of the number of cows previously kept in the free-stall system to the total number of cows in the group. At the analysed farm, the total number of animals entering the milking parlour was 14. The above index was referred to as the structural index of the milk cow group (i_s).
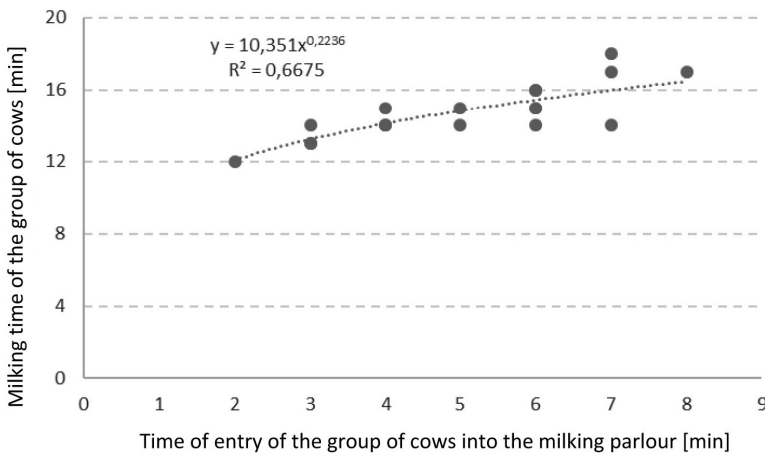

FIGURE 2. Relations between entry of a group of cows into the milking parlour with the milking time (own investigation)

The value of the structural index of the milk cow group (i_s) falls within the range from 0 to 1, provided however that 0 means that the group is only made up by cows which were kept in the tied system before the experiment. On the other hand, 1 means that the group is only made up by cows from the free-stall system.

Figure 3 presents relations of the structural index of the milk cow group (i_s) with the time of entry of cows into the milking parlour.

Based on the progress of changes presented in Figure 3, one can conclude that, along with growing share of animals previously kept in the free-stall system within the group of cows, the time which the animals spend on entering the milking parlour is reduced. The coefficient of determination (R^2), which characterises matching of the exponential curve to the investigation data, is 0.78.

Figure 4 presents relations of the structural index of the milk cow group (i_s) with the milking yield at the milking parlour.

Growth in the structural index of the milk cow group (i_s) is accompanied with gradual increase in milking yield per cow at the milking parlour. The coefficient of determination (R^2), which characterises matching of the exponential curve to the investigation data, is about 0.84.

At the analysed farm, milking was performed in a herringbone milking parlour. As the barn was only occupied in December 2015, and the herd was enlarged with 13 primiparas and 17 heifers, one could observe how fast cows from the free-stall barn were taking their places in the milking parlour, and how it compared with cows from the tied keeping system. Three groups of animals, of 14 animals each, were brought in for milking. In group one, entry into the milking stalls took on average 3.17 min. In this group, milking took on average 13.5 min, with the average milk yield of 16.75 kg per cow.

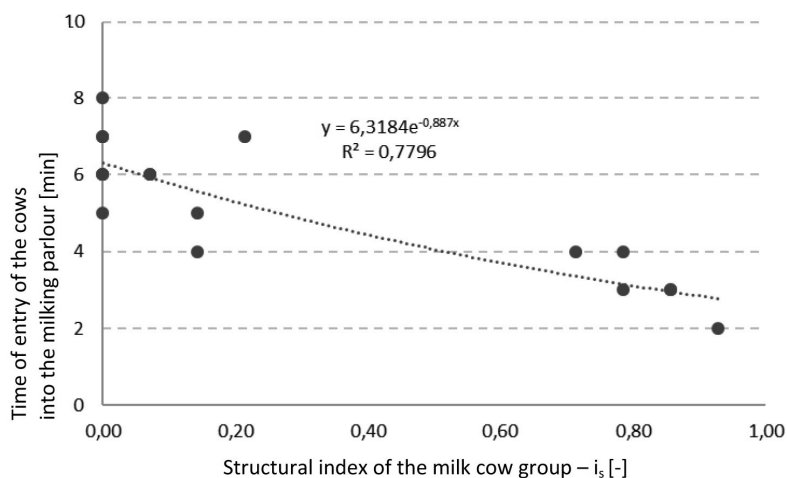In comparison with milking robots, the milking time seems relatively long,

FIGURE 3. Relations of the structural index of the milk cow group (i_s) with the time of entry of the cows into the milking parlour (own investigation)

The figure shows a scatter plot with the equation:
$$y = 6.3184e^{-0.887x}$$
$$R^2 = 0.7796$$

with x-axis labeled "Structural index of the milk cow group – i_s [-]" and y-axis labeled "Time of entry of the cows into the milking parlour [min]".
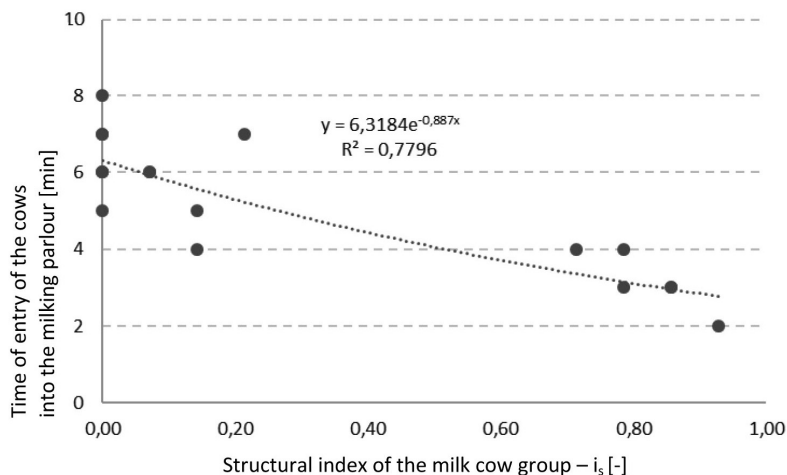
FIGURE 4. Relations of the structural index of the milk cow group (i_s) with the milking yield at the milking parlour (own investigation)

but one ought to remember that the milking time was measured from the time of closing the gates of the milking stalls until the opening thereof, i.e. the cows which ended milking first had to wait in their positions for the last cows. In group one, milking covered on average 11.5 primipara cows which had been kept at a free-stall barn before and had also been milked in a herringbone milking parlour. This demonstrates that young animals which feel the need to be milked do not have problems with entering their milking positions. In group two, dominated by animals from a barn with the tied keeping system, the time of entry into the milking parlour increased to 5.5 min. Although the average amount of milk was 13.47 kg per cow, the cattle was not very willing to enter the milking positions. What is more, the milking time in this group also grew to 14.3 min. The whole group three was made up by cows from a barn with the tied keeping system. The average time of entry was about 6.67 min, whereas the average milking time was 16.5 min. The amount of milk obtained per cow in group three was 10.25 kg and was the lowest in the whole herd. For the group of cows characterised with the lowest efficiency, the lowest benefits connected with using the milking parlour were thus obtained.

The variance analysis involved investigation into significance of the time of entry into the milking parlour, milking time of particular cow groups and their individual milk yield (l per cow) for a varying number of animals previously kept in the free-stall system, within the group. The results of one-dimensional significance tests are presented in Table 2.

Results of the variance analysis identifying influence of the share of cows from the free-stall system onto factors connected with milk production demonstrated significance at the confidence level of 95%.

The conducted investigation confirmed that both the benefits and effi-

TABLE 2. Results of one-dimensional significance test for the analysed factors related to milk production

Effect	SS	df	MS	F	p
Time of entry into the milking parlour					
Cows from free-stall system	4.1667	1	4.1667	5.9211	0.0378
Milking time of the group in the milking parlour					
Cows from free-stall system	6.0000	1	6.0000	7.3636	0.0239
Individual milk yield					
Cows from free-stall system	9.3750	1	9.3750	11.9455	0.0072

ciency of using mechanical milking systems may depend on numerous factors, including evaluation of the animals, their behaviour and production indices. This area of analysis fits into the broad spectre of investigation concerning efficient use of milking systems, which has already emphasised the influence of herd concentration onto intensity of using milking systems [Gaworski and Boćkowski 2012], role related to size of the milking parlour in confrontation with the number of cows in the herd [O'Brien et al. 2012], influence of milking frequency onto milk yield [Castro et al. 2012], essence of the milking parlour functional characteristics [Gygax et al. 2007] and importance of regional conditions [Fernandes et al. 2014] in the context of efficient use of milking systems [Gaworski et al. 2013].

SUMMARY

As the investigation conducted at the selected farm confirmed, the movement of cattle at free-stall barns may be influenced by the milking system used. Multiplicity of milking cycles, offered by automatic milking systems, allows free access of cattle to that activity. A predefined daily schedule is applied at barns where cows are milked at the milking parlour, which the animals must observe.

The investigation confirmed that young cows and cows at the peak of the lactation period are more willing to be milked, whereas cattle at later stages of lactation does not feel this urgent need to be milked. One may state that cows which are milked more frequently demonstrate higher lactation efficiency as compared with cows milked twice a day. Higher milking frequency at milking robot results from the fact that the robot also acts as the fodder station, whereas the milking parlour only performs the milking function. However, there are no significant differences between controlled movement of cattle at the barn and its uncontrolled movement.

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Streszczenie: *Wpływ struktury stada krów na wskaźniki pozyskiwania mleka w dojarni.* Celem pracy była analiza ruchu bydła w strefie obory wolnostanowiskowej poprzedzającej wejście krów do hali udojowej z uwzględnieniem kryterium zróżnicowania stada. Zróżnicowanie stada uwzględniało krowy, które na etapie uruchamiania dojarni w nowej oborze utrzymywano wcześniej w systemach wolnostanowiskowym i uwięziowym. Badania wskazały, że gdy w grupie wchodzącej do dojarni wzrastał udział krów utrzymywanych wcześniej w systemie wolnostanowiskowym, to zmniejszał się czas wchodzenia zwierząt do dojarni. Zwrócono także uwagę na wzrostową tendencję wydajności pozyskiwania mleka od jednej krowy wraz z rosnącym udziałem krów z systemu wolnostanowiskowego w grupie wchodzącej do dojarni.

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