

Studies of Operating Parameters in Milking Robots With Selectively Guided Cow Traffic

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Abstract. Milking robots have been launched on Latvian dairy farms only recently. As the technology differs essentially from that of traditional milking, with the introduction of new technology a range of questions has arisen that have not been topical before. For instance, there has been uncertainty about determining the optimal size of the group of milk cows for robots as well as about planning the robot location and the waiting box.

On installing robots in reconstructed barns, it came out that it was not possible to stick to the designs offered by the companies, and after milking the cows were not sent to the barns but back to the waiting box. As a result, the milked cows had a chance to visit the robots repeatedly. Therefore, a question arose – how much does the repeated visiting of robots influence the effective load.

Moreover, there has been uncertainty about the correct location for the robot in relation to the waiting box using several robots. It was observed that usually in such a case one robot is visited more than the other.

The present research tries to answer these recurring questions. The research results showed that the optimal size of the group of cows served by one robot depends on the average milking time and the time necessary for washing the milk line. If the cows return to the waiting box after milking, the effective load of the robot decreases. The location of the robot in the waiting box in relation to the entrance gate essentially influences the number of visiting one or the other robot per day.

Key words: Milking robots, automatic milking systems, size of the group of cows, waiting box design

INTRODUCTION

Cow milking with automated milking equipment or milking robots has been recently introduced on Latvian dairy farms. Milking robots are completely automated devices which the cows can enter at free choice and can get milked at any time of the day without participation of people. Considering that the new technology cardinally differs from cow milking with traditional equipment, during the introduction of robots many unclear questions are faced that are related to changes in barn design and application of new equipment.

In Latvia, milking robots VMS of the company ‘DeLaval’ with selectively guided cow traffic feed first system are used on all farms. On the application of this system, cows from the lying area can get into the feeding area only through a one-way gate. In order to get back to the lying area, the cows from the feeding area must go through the pre-selection gate where they are directed either to the waiting box if the programmed milking time is due or back to the lying area. After milking, the milked cows are directed back to the feeding area from where they go once more through the pre-selection gate to get back to the lying area (Fig. 1).

Considering the fact that in Latvia milking robots have been installed also in barns which have been built earlier and in which other milking methods have been used, it is not always possible to implement the above described cow traffic system precisely. On some farms the robots are located in this manner that after milking, cows are not directed to the feeding area as envisaged by the recommendations of the robot production companies, but back to the waiting box. This way the cows have a chance to visit the robot repeatedly at short intervals without the set inter-milking interval. Therefore, a question arises – what influence does it have on the technological process as a whole.

There is also uncertainty about the design of the waiting box. It is important to know whether the configuration of the waiting box as well as the location of the robots and the entrance gate in the area influence cow traffic to milking.

Our former research shows that also the size of the cow group milked by robots has great importance. If the selected group is too small, robot idle time occurs that, considering the high price of the equipment is not permissible. If, on the other hand, the group is too large, the robots fail to milk all the planned cows. Therefore, it is important to state the factors determining the optimal size of the group of cows.

In order to find answers to the given questions, publications by researchers from countries with a long experience in milking robot use were studied, for instance, Wendl et al. (2000), Benninger et al. (2000), Purucker et al. (2001), and Artmann (2005); however, satisfactory answers were not found.

Therefore, the following research tasks were set:

- To clarify if the use of selectively guided cow traffic feed first system returning of cows right after milking to the waiting box does not decrease the efficiency of robot application,
- To clarify if the configuration of the waiting box as well as the location of the robots and the entrance gate influence cow traffic to milking,
- To clarify what factors determine the size of the cow group milked by robots.

MATERIALS AND METHODS

The research was performed on three farms (A, B and C). On every farm the cows were milked by two milking robots VMS by the company ‘DeLaval’. The farms had different design of waiting box and cow traffic after milking.

On farm A (Fig. 1) the cows separated in the pre-selection gate get into the waiting box and after that they enter any of the robots at free choice. After leaving the robots they get into the feeding area at once.

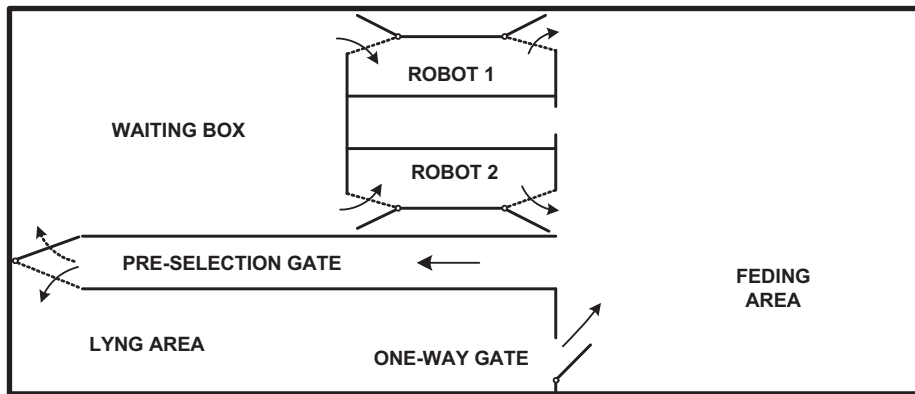


Fig. 1. Design of farm A.

On farm B (Fig. 2) the cows from the robot No. 2 get into the feeding area, from the robot No. 1 - back to the waiting box. These cows get into the feeding area through the post-selection gate of the waiting box that opens only for the milked cows.

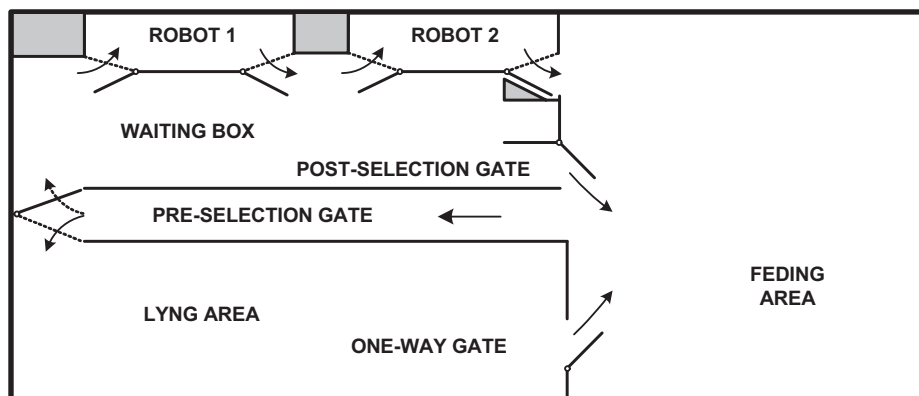


Fig. 2. Design of farm B.

On farm C (Fig. 3) all cows get back to the waiting box after milking. The milked cows from the waiting box get into the feeding area through the post-selection gate of the waiting box.

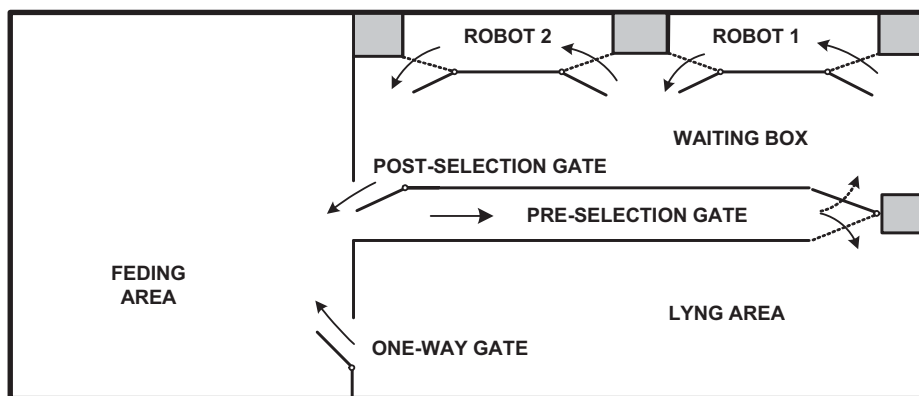


Fig. 3. Design of farm C.

As it can be seen in Figs. 1-3, waiting boxes on different farms differ according to their configuration, as well as according to the location of the milking robots, and pre and post-selection gates in the waiting box are different.

Table 1 shows the indicators characterizing the groups of cows milked by robots.

Table 1. Description of cow groups

Indicator	A	B	C
Number of cows in the group	108	97	94
Average milk yield per day, kg	19.47	24.27	20.60
Average number of milking per day	2.8	2.5	2.5
Average milking length, min	7.48	8.,67	8.87

The experiment lasted for 15 days. The data necessary for the research were obtained from the robot management system and after that processed.

RESULTS AND DISCUSSION

On farm B, after having been milked by robot No. 1 (Fig. 2), but on farm C – by both robots, the cows get back into the waiting box. There they have an alternative: either to go to the feeding area at once after the post-selection gate, or stay in the waiting box, or repeatedly enter the robot. If staying in the waiting box does not essentially influence the total technological milking process, repeated entrance to the robots without milking can reduce their efficient throughput capacity.

In Fig. 4 we can see that on farm B, where two robots are milking a group of cows consisting of 97 animals, an average 20 cows per day have entered the robots without milking, but on farm C (94 cows in the group) – 24 cows. The research results show that on farm B in such a way one robot is uselessly engaged for 20 min. per day, but on farm C – for 30 min. As on both farms the idle time of the robots is approximately 10% (Fig. 6), it is questionable whether in this case repeated entrance to the robots essentially reduces their operation efficiency. An obstructive factor may occur when the size of the cow group is close to the optimal.

The research results show that on farm C where the milked cows return to the waiting box from both robots there is also a larger number of repeated robot visits.

Figure 5 shows that on none of the farms both robots are equally loaded. More often the cows are visiting the robot which is in their sight right after they have entered the waiting box and which is located in the direction of their traffic. For instance, on farm A (Fig. 1) and B (Fig. 2), it is robot No. 2, but on farm C (Fig. 3) – robot No. 1. Thus it is possible to conclude that the location of the waiting box entrance and exit gates as well as the location of the robots has to be planned very carefully. If several robots are used, their location should be considered as a uniform system.

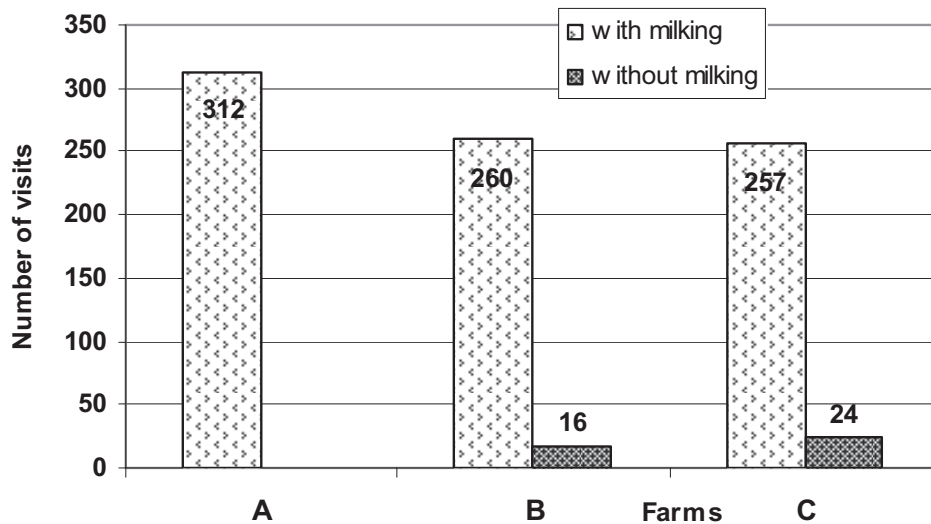


Fig. 4. Total average number of visits to both robots per day.

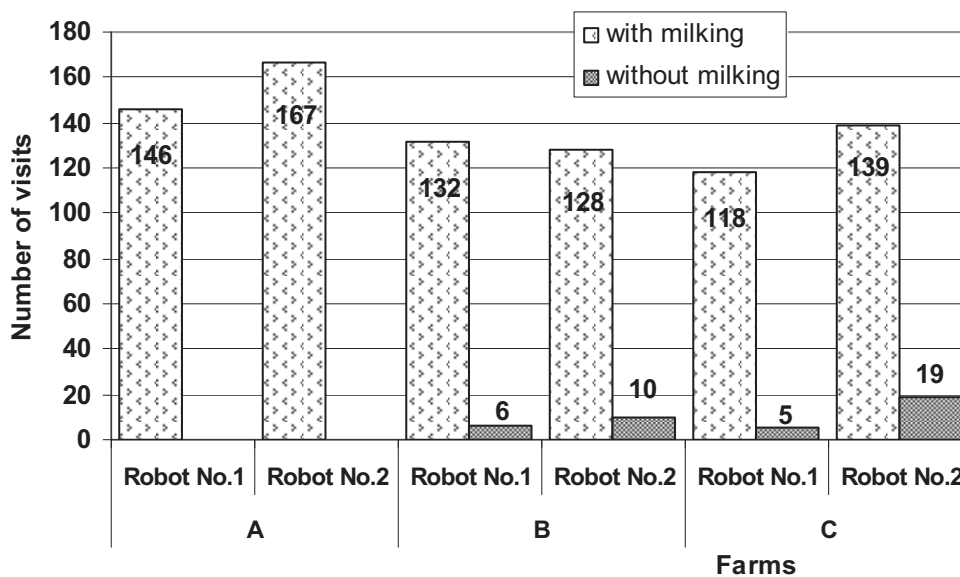


Fig. 5. Average robot visits per day.

Figure 6 shows the average robotic load per day. It is comprised of cow milking, robot visits without milking (on farms B and C), technological time and idle time. Technological time is necessary for draining the milk reservoir and washing the milk line, but idle time occurs when the robot is ready for milking but the cow has not entered it.

In Figure 6 we can see that on all farms there is a considerable robotic idle time regardless of the fact that the cows are milked in accordance with the set milking times per day (Table 1 – the average number of milking per day 2.8; 2.5; and 2.5 times). It means that the number of cows in groups can be increased.

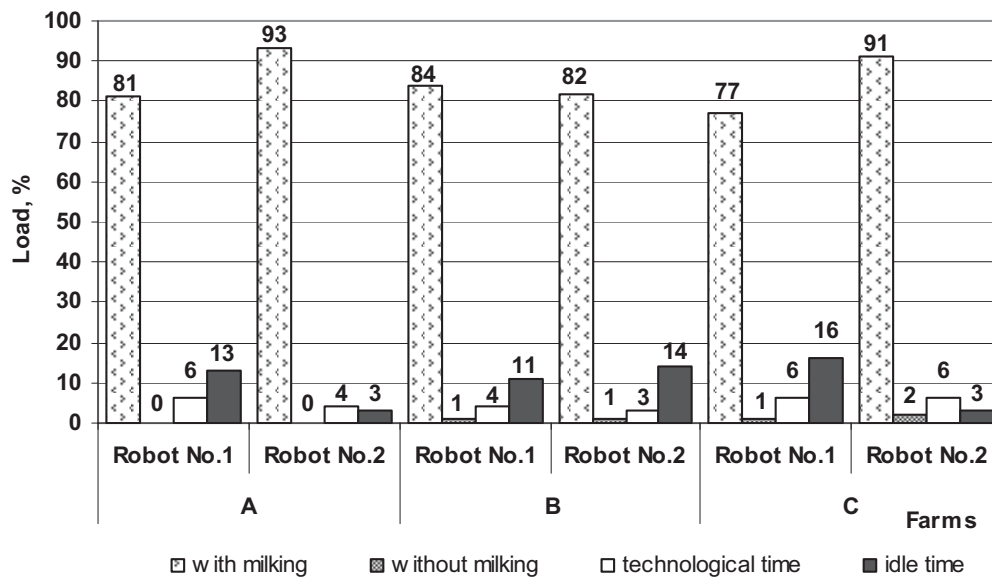


Fig. 6. Average robotic load per day

The optimal number of cows that can be served by one robot is not an unambiguous value. It is influenced by factors that are different on different farms. The most influencing factors are the length of milking, the time necessary for automated udder preparation and attachment to the milking device, and the technological time. Besides, the system determining cow traffic to the milking robots has a great influence, too. In practice three cow traffic systems are used: free cow traffic, guided cow traffic and selectively guided cow traffic. Today there is no unequivocal answer which of them is best. Every one has its disadvantages and advantages.

Involvement of people in the cow traffic is a very important factor. Not always and not all cows enter the robots at free will, the laziest have to be driven. Here arises an essential question: how often should it be done? On our farms where the experiments were performed the cow traffic technology was different. On farm A the person on duty in the barn did it regularly, directing the cows that had exceeded the set inter-milking interval, to the waiting box (the interval was only from 2:00 to 6:00). In turn, on farm B the driving of cows was done irregularly as the auxiliary worker for 5 hours in the morning and 5 hours in the evening was busy working in another barn. At last, on farm C the cows were driven in the morning, i.e., at the beginning of the working day and in the evening before going home. During the day the driving is irregular when the worker in the barn is free.

The influence of such versions of work organization on visiting robots can be seen in Figure 4. At approximately equal milking length on farm A the number of robot visits per day is the biggest. Besides, also the group of the cows served is larger and also the labour consumption of the workers increases.

From these observations it is possible to conclude that the optimal size of the group of cows milked with robots is individual and it can be determined only experimentally considering the definite situation. Besides, in our case the number of cows in groups on all farms can be increased at least by 10 cows.

CONCLUSIONS

1. One of the main factors of robot application efficiency is the size of the group of cows to be milked. The robots should serve a possibly larger group of cows in order to be loaded without special idle time as otherwise the finances used for their purchasing and operation will not be cost-effective.

2. The optimal size of a group of cows is individual for every definite farm. It is influenced by the average milking length for one cow, including the time necessary for automated preparation of the udder and its attachment to the milking cluster. Also the system of cow traffic and work organization on the farm considering the involvement of people in the milking process is of great importance.

3. If several robots are used for milking a group of cows, the load of every separate robot is influenced by the interrelated location of the waiting box gate and the robots. The cows visit more often the robots which are easily accessible and located in the direction of their traffic.

4. If the design of the milking area envisages the return of the milked cows into the waiting box, repeated robot visits are decreasing their efficient load.

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