STUDIES OF OPERATING PARAMETERS IN MILKING ROBOTS

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Abstract. The research has been carried out on the dairy farm of the Latvia University of Agriculture training and research farm „Vecauce" where two milking robots VMS of the company DeLaval are introduced. In the research the milking capacity per milking robot a day and cow milking frequency per hours as well as the load have been stated. The research shows that every hour one robot milks in the average 5.5 cows. The robotic load at the present cow herd (88 cows) is 80 %. The cows that are in the first third of the lactation period are milked in the average 3.7 times, in the second third – 3.0 times, but in the third – 2.1 times per day. According to the results of the research it can be concluded that the robotic load in all hours of the day is approximately the same. In order to achieve more complete loading of the robots the number of cows in the herd should be increased up to 100 – 110 animals. Milking with robots it is possible to ensure the number of milking times per day in compliance with the lactation phase. A special worker for driving the cows is not needed in robot operation.

Keywords: robotic milking, robotic milking capacity, robotic load, cow milking frequency.

Introduction

On the Latvia University of Agriculture training and research farm „Vecauce" milking robots were introduced in 2007 [1] and they were one of the first robots of this kind in Latvia. At the same time also research in robotic milking was started. It was related to two different issues: with transfer to the new technology as the cows before that were handled in stanchion barn and milked in pipeline as well as with the analysis of the peculiarities of milking robot operation [2, 3]. In turn, the research carried out in 2008 was done at stabilized technological processes and with that it was possible to evaluate the actual efficiency of the milking robots and to distinguish the most essential advantages and disadvantages.

The technological process of robotic milking cardinally differs from milking with traditional equipment. Milking robots are completely automated devices that can be visited by cows at free choice any time during 24 hours and milked without help of people. Though, application of such technology raises many new questions that were not faced before, for instance, how many times per day the cows visit robots, what size of herd can be served by one robot etc.

It should be mentioned that partly these issues are investigated in the countries where robots are widely applied, for instance, in the Netherlands, Germany and Sweden [4-6] but usually there are considerable differences among the obtained results. It can be explained by peculiarities of animal farming in different countries.

Considering this fact we considered it to be purposeful to carry out the research in operating parameters in milking robots introduced in Latvia in order to state:

- cow milking frequency per day;
- cow milking frequency per hours a day
- robotic load per day;
- optimal size of the herd that can be served by one robot;
- robotic frequency per day depending on the lactation phase.

Materials and methods

The research was carried out in the Latvia University of Agriculture training and research farm "Vecauce" newly built barn where loose handling of cows is practiced. In this barn the cows are divided in four sections where in one of the sections the cows are milked with two milking robots VMS of the company DeLaval (Figure 1), but in the other three sections – with parallel parlour equipment.

For directing the cows towards the milking robots on the farm "Vecauce" feed first cow traffic technology is applied. Its distinguishing feature is that the cows which wish to get from the recreation zone into the milking robot should move along the following route: through the one-way gate in order to get to the feeding zone, then through the segregation gate that directs the cows either into the waiting yard or feed concentrate feeding zone, but from the waiting yard the cows can enter any of the vacant robots. Here the cow gets a definite ration of feed concentrate and is automatically milked, and after that let back into the feeding zone.

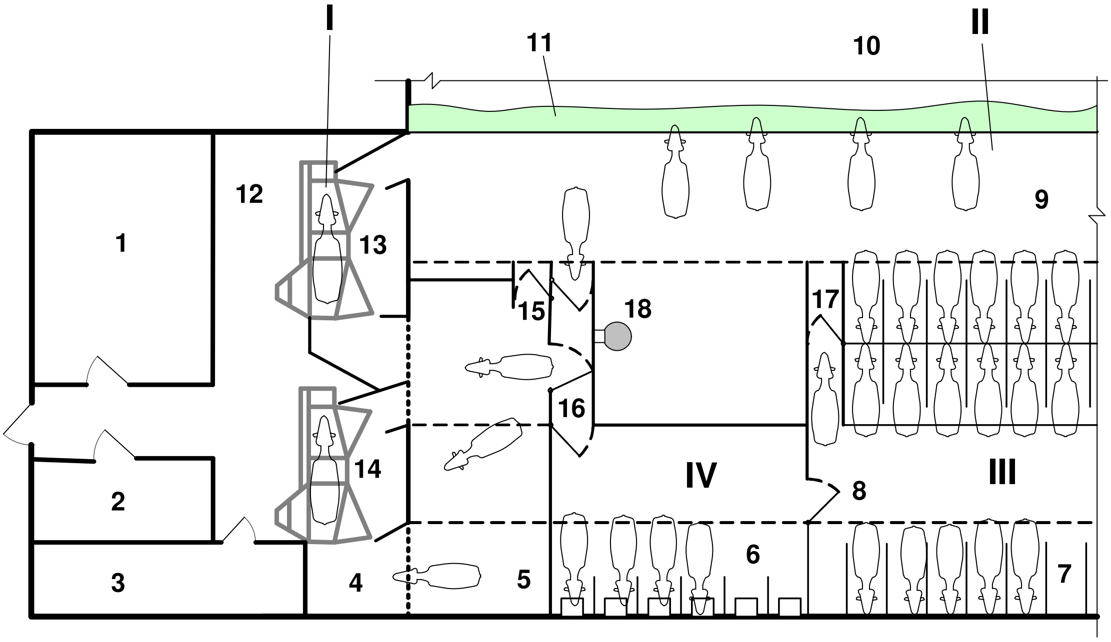

Fig. 1. **Planning of the robotic milking section on the Latvia University of Agriculture training and research farm "Vecauce":** I – milking zone; II – feeding zone; III – recreation zone; IV – feed concentrate feeding zone; 1 – milk room; 2 – office; 3, 12 – corridor; 4, 5 –waiting yard; 6 – feed concentrate boxes; 7 – boxes; 8, 17 –one-way gate; 9 – passage; 10 – feeding table; 11 – feed mix; 13, 14 – milking robots; 15, 16 – segregation gate; 18 – cow-combs

If, in turn, the segregation gate has directed the cow into the feed concentrate feeding zone, it can consume the planned feed concentrate ration and after that get back through the one-way gate into the recreation zone. This way the cows can circulate during the day plenty of times. Though, they can get into the waiting yard only after definite time that has passed after milking as the segregation gate can be locked accordingly.

The experiment lasted for 15 days. During that period of time there were approximately 88 cows in the section. The information stored in the robot control computer was used in the experiment and afterwards processed.

Results and discussion

On e of the most essential characteristics of robotic load is cow milking frequency per day. It characterizes the carrying capacity of the robot. Considering the economic reasons possibly large capacity is advisable as robot costs are high.

The cow milking frequency is influenced by:

- comfortable access to the robot (using direct access to the robot or going through different gates and passages);
- habits and stimuli of cows to visit the robot (formation of conditioned reflex, supply of feed concentrate in the robot, forced driving of cows);
- possibility only for the cows that are programmed for milking to get into the robot (free or selective access to the robot);
- productivity of cows (cows with higher milk yield have a tendency to visit the robot more often and get milked);
- length of milking (depends on the milk yield and speed of milking) as well as the length of technological operations that is needed to prepare the cow for milking and for milking;

- length of intervals necessary for emptying of the milk tank and washing of milk lines and the tank.

Therefore, it is possible to draw a conclusion that on different farms the average milking frequency per day can be considerably different.

During the experiment the milking capacity per milking robot a day was recorded specifying the times when the management system has refused milking of a definite cow.

The obtained research results are summarized in Figure 2.

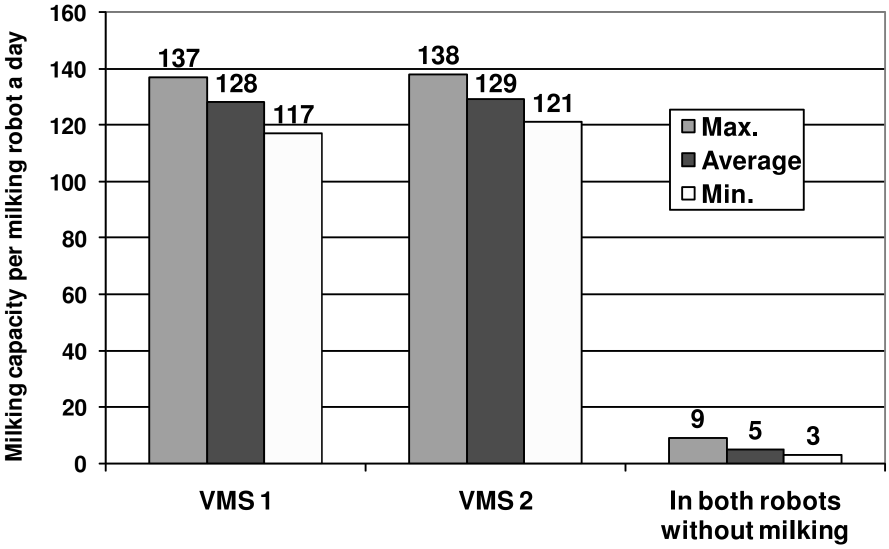

Fig. 2. **Average milking capacity per milking robot a day during the experiment**

The main conclusions that can be drawn based on the figure are as follows:

- both robots are visited at the same frequency (in the average 128 and 129 times a day);
- considering that the cows that are milked in the first robot get back to the waiting yard, they can enter the robot repeatedly, that is, also when it is not planned to milk them;
- the research where the milking capacity per milking robot a day was stated has been carried out with comparatively high accuracy (accuracy index Sx % = 1.2 %).

The total milking capacity per milking robot per hours a day for both robots can be seen in Figure 3.

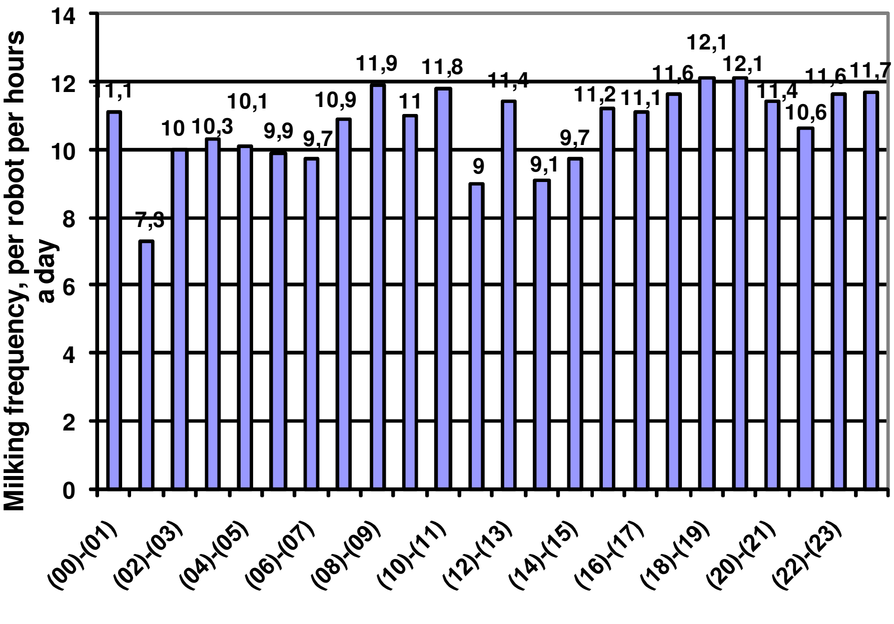

Fig. 3. **The total milking capacity per milking robot per hours a day for both robots**

The research shows that in the period of the experiment the average milking capacity per milking robot has varied in the range of 7.3 to 11.9 times a day.

If the day (24 hours) is divided in three periods of time (according to hours) it can be seen that from 00.00 to 08.00 there have been in the average 9.9 visits to the robot, from 09.00 to 16.00 – 10.6 visits, but from 17.00 to 24.00 – 11.5. It proves that a little larger activity can be observed in the afternoon and evening hours.

The obtained results showing the daily robotic load are shown in Figure 4.

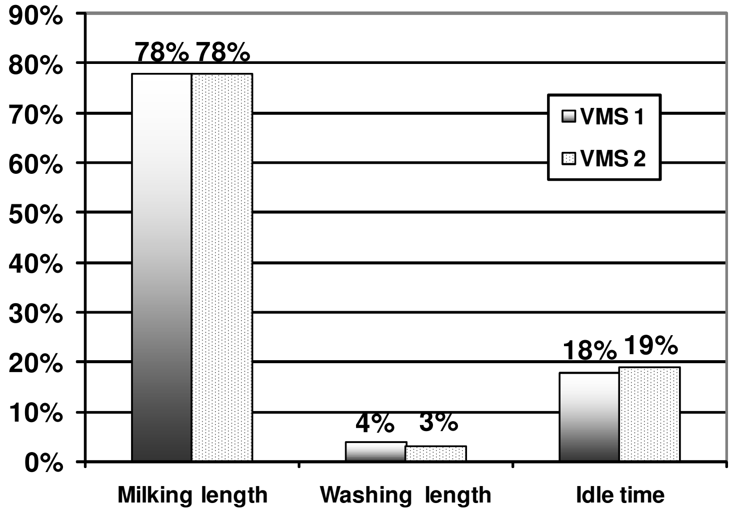

Fig. 4. **Daily robotic load**

A conclusion can be drawn from the figure that both robots have equal load and their idle time is 18 and 19 % accordingly.

The robot is appropriately loaded when there is a cow in it and the cow is being milked. Though, also the additional time that is needed to empty the milk tank and wash the milk line as well as to wash a separate part of the milk pipeline (if milk is not qualitative) should be added to the usefully used time.

It is not actually possible to reduce the length of milking or emptying of the milk tank and washing the milk pipeline. Though, the robotic idle time should be reduced to the minimum as it is necessary according to economic considerations.

Analyzing the situation on the farm it can be concluded that:

- one of the reasons for idle time is the complicated system of gates that interrupts with free traffic of cows into the milking robot, but at present it is not possible to eliminate it;
- there is not an optimal number of animals in the herd as the robots have 18.5 % idle time.

In order to reduce the useless idle time it would be purposeful to increase the number of animals in the herd leaving a small idle reserve (5 %) that could compensate the possible infrequency of milking times. Knowing that on the given farm the average length of milking one cow is 8.8 min. and every cow is milked averagely 2.9 times per day the number of cows in the herd could be increased to 100 – 110 cows or 50 – 55 cows calculating per one robot.

In order to obtain the maximal amount of milk it is necessary to ensure due milking of cows. This factor is very important at the beginning of the lactation period. If a cow is not milked sufficiently often 5 – 10 % of the possibly obtained milk can be lost. It has been proved [4, 6] that at the beginning of lactation depending on the productivity cows are to be milked 3 – 5 times, in the middle stage of lactation 2 – 4 times, but at the end of lactation 2 – 3 times per day. Based on this statement milking in robots for every cow the optimal inter-milking time has to be set considering the productivity and lactation phases of the animal. Though, the question stays open whether the cows always fit in the setting.

The results of the research related to the milking frequency per day using robots are summarized in Figure 5.

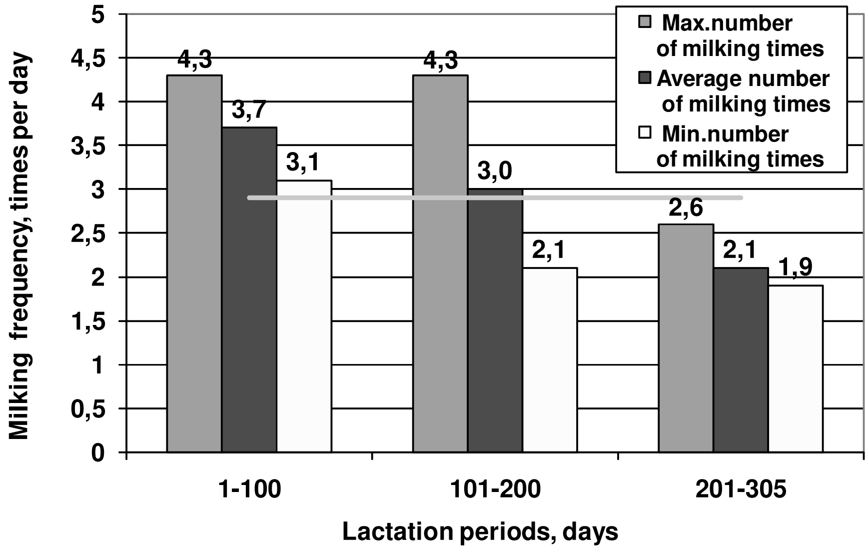

Fig. 5. **Milking frequency per day of cows at the beginning, middle and end of the lactation period**

According to the figure the cows are milked in the average 2.9 times per day that complies with the data published in special literature [4, 6]. Nevertheless, these are average indices and they do not completely reflect the real condition. To make the research more valuable additional experiments should be made to state the situation about separate animals.

Conclusions

1. Both milking robots introduced on the Latvia University of Agriculture training and research farm „Vecauce" have equal load.
2. Considering that leaving the first robot the cows get back into the waiting yard they can return to the robot for the second time, but such cases are not frequent and it cannot considerably influence the robotic load.
3. Robotic load during the hours a day is even with a small decrease during the night hours and increase in the evening.
4. The robots are not fully loaded. Therefore, the number of the served cows could be increased up to 100 – 110 cows. The cows are milked in the average 2.9 times a day that complies with the zoo-technical requirements.
5. The cow traffic to milking used in Vecauce without a special worker for it is rational and economically well-grounded.

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