

Robotic milking of dairy cows

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Abstract. In countries with developed dairy farming milking robots are gaining wide popularity. The first milking equipment of this kind was installed in Latvia in 2007 and found interest among partitioning animal breeders and among scientists. The main feature of the milking robots is that cows can be milked independently, without human assistance and “on demand”. The aim of our research was to state how often the cows visited the robots, and to compare the load (capacity) and quality of the obtained milk to traditional milking equipment. In our experiments, the cows visited the robots 2.9 times a day, on average. Two robots that served a group of 73 cows were loaded to 65%. Therefore, the capacity can be enlarged to 110 cows. With the use of robots, milk quality indices were higher than milking with stall-type equipment with parallel location of animals.

Key words: milk cows, robotic milking, milking frequency, robot load, milk yield, milk quality

INTRODUCTION

The first practicable ideas of completely automated milking equipment (milking robots) appeared at the beginning of 1970s. Since then active research work has been carried out. An experimental robot sample was produced at the beginning of the 1990s and was put into use a few years later. Today approximately five thousand milking robots are in use in countries with highly developed dairy farming (Lind et al., 2000; Muižniece, 2004).

The Baltic States have begun to show interest, as well: the first robots in Estonia were employed in summer, 2006, and in Latvia, in 2007 (Laurs, 2007).

The technological process of robotic milking essentially differs from the traditional method in which farmers directed groups of cows to the milking area and back to the feeding and recreation area. Robots work completely automatically. Therefore, the cows can visit them at will, at any time during twenty-four hours. Nevertheless, many uncertainties remain, especially the time necessary for accommodation of the cows, the maximal number of milking cows, the quality of the obtained milk, etc.

Analysis of the relevant literature (Schön et al., 2000; Freiburger et al., 2005; Fübber & Kowalewsky, 2005) shows that such research has been carried out in several countries where robots are in wide use. However, different results indicate peculiarities of dairy farming in different countries. Therefore, we considered it to be purposeful to carry out similar research with milking robots in Latvia. The main tasks of the research were as follows:

- to state the frequency of milking using robots;
- to state the possible load of the robots;
- to compare quality of the obtained milk using robots and traditional milking equipment.

MATERIALS AND METHODS

The research was carried out on the training and research farm of the Latvia University of Agriculture „Vecauce” in the newly built cow barn „Līgotnes”. The cows are divided into four sections. In one section the cows were milked by two VMS milking robots manufactured by the DeLaval company (Fig. 1); in the other three sections, stall-type milking equipment with parallel location of cows was used.

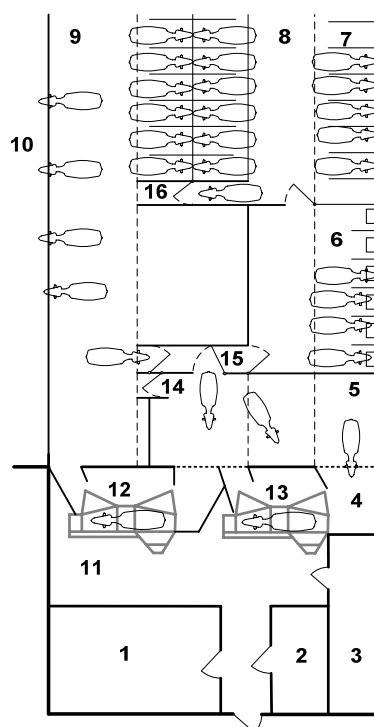


Fig. 1. Planning of premises and location of the equipment in the functional section operated by robots: 1 – milk room; 2 – computer compartment; 3 – technical corridor; 4 – milking anteroom; 5 – pre-milking area; 6 – mixed concentrated feed area; 7 – row of boxes; 8, 9 - manure passages; 10 - feeding table; 11- corridor; 12, 13 - milking robots; 14 - identification gate; 15 - sorting gate; 16 - passage corridor.

The “feed first” cow traffic technology is applied. Specifically, cows moving from the recreation area to the milking robots need to move first through one-directional gates to enter the feeding area, then through the sorting gate that directs them to the robot pre-milking area or to the concentrated feed area. Other research

(Schön et al., 2000) shows that milking more than 4 times in twenty four hours restricts essential growth of milk yield and reduces the efficiency of robot application. Therefore, during the experiment, cows were allowed to visit the robot only after a 6-hour interval.

If the sorting gate has directed the cow into the concentrated feed area, the cow can reach one of the five concentrated feed stands and consume the planned concentrated feed ration, then move through the one-directional gate to return to the recreation area.

If the sorting gate has directed the cow into the pre-milking area (which holds only 8 cows), the cow can remain there until one of the two milking robots is disengaged.

Once in the robot stall, the cow receives a defined ration of concentrated feed and is automatically milked, then is let back out to the feeding area from where the traffic continues along the above described route. The system allows for unlimited traffic of cows during twenty-four hours.

The “feed first” system has several advantages compared to the other two traffic systems described in the special literature (free and semi-free cow traffic):

- the cows’ desire for concentrated feed stimulates their traffic towards the robots;
- cows that do not need to be milked cannot get into the pre-milking area.

The experiments of milking by robots were begun 1.5 months after the cows were housed in the new barn, when they had adjusted to the new surroundings and the technological process had become stable.

The experiment lasted for 45 days and was divided into three 15-day periods. The average number of cows was 73. The data necessary for the experiment were obtained from the robot control computer.

All cows milked by robot were considered to determine the average number of milkings in twenty four hours. Percentage distribution of milking cases was calculated according to the number of cows visiting the robot and average indices were stated.

To determine the robot load, information stored in the robot data base on a daily basis was used.

To determine milk quality, the certified laboratory analysis results used were obtained from milk samples of the robotic milking as well as from stall-type milking equipment.

RESULTS AND DISCUSSION

The average number of milkings per day of the group of cows milked by robots is shown in Fig. 2.

The figure indicates that the technological process of milking cows was comparatively stable throughout the experimental period. The maximal frequency of visiting robots was 3.4 times per day, the minimal – 2.9 times per day ($R^2=0.0005$). These results fit well within the recommended robot-visiting interval (2.5–3.0 times per day).

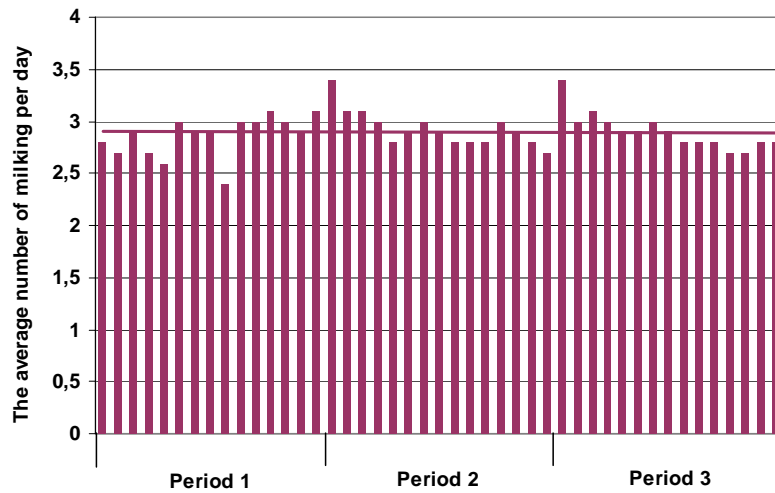


Fig. 2. The average number of milkings per day for cows milked by robots.

More detailed distribution of milking times by research period can be seen in Fig. 3.

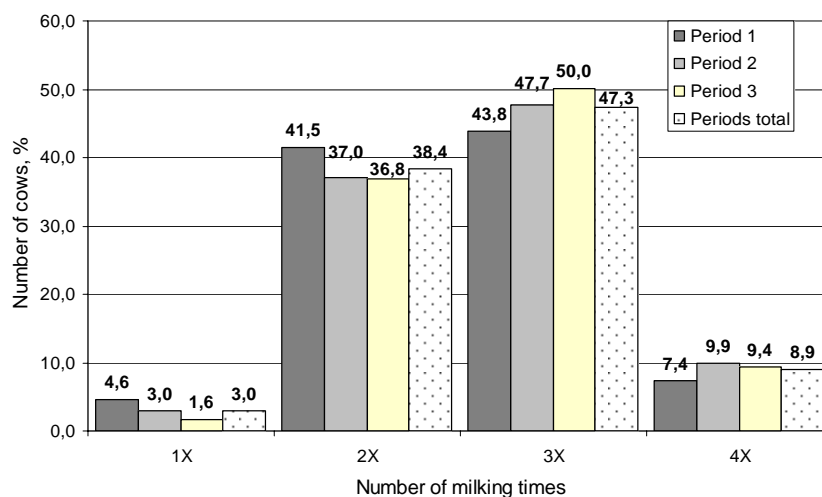


Fig. 3. Distribution of milking times according to separate research periods.

The research results show that during the entire experiment 8.9% of cows were milked four times ($S_{\bar{x}\%} = 4.1\%$), 47.3% - three times ($S_{\bar{x}\%} = 2.3\%$), but 38.4% - two times ($S_{\bar{x}\%} = 3.2\%$). Only 3.0% of cows were milked only one time ($S_{\bar{x}\%} = 4.8\%$).

According to the existing statements, cows with high milk yield should be milked three and four times per day, but all other cows, two times. Nevertheless, at present our research does not include the milk yield, therefore we cannot ascertain the possibility of such correlation. It should be mentioned that some cows (in our research 3.0%) did not wish to visit the robot willingly, as proved also by other scientists (Fübbeker & Kowalewsky, 2005).

The robot load stated in the research is given in Fig. 4.

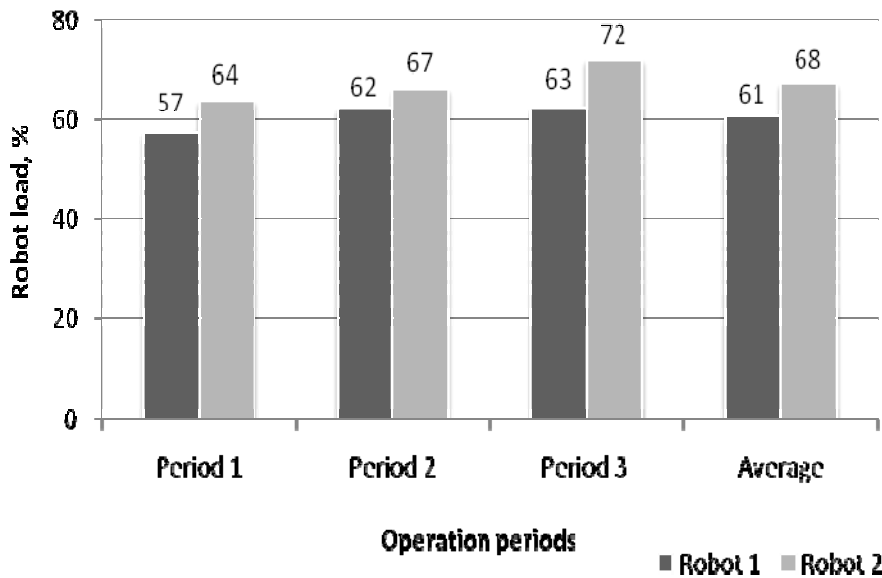


Fig. 4. Robot load.

The figure indicates that the robot load stated in the experiment ranges from 57% to 72% (average 64.5%, $S_{\bar{x}\%} = 2.3\%$), meaning that it is possible to enlarge the herd of cows milked by robots thereby improving the efficiency of robot application. Practically, this robot load can be planned at about a 95% level to compensate for possible accidental interruption of robot operation. Therefore it can be calculated that the number of cows in the section operated by robots can be enlarged up to 110 cows, calculating 55 cows per one robot. Other researchers (Fübbeker & Kowalewsky, 2005) show that two robots can serve 92–118 cows, which agrees with our findings.

Fig. 5 shows the changes of the somatic cells in milk that is obtained milking by robots as well as using the stall-type equipment with parallel location of animals during milking.

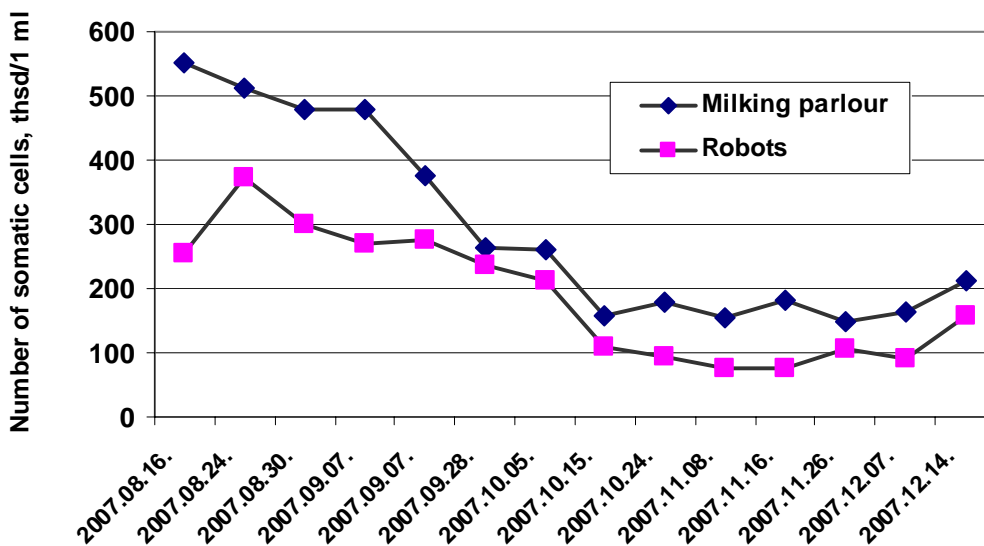


Fig. 5. The number of somatic cells in 1 cm³ of milk milking by robots and „parallel” type milking equipment.

The obtained results show that the number of somatic cells is smaller in milk obtained from robotic milking than with the stall-type equipment: accordingly, the quality of milk obtained in milking with robots is higher. The explanation is that the high technical level of the robots ensures better preparation of the udder, automatic separation of low grade milk as well as more qualitative washing of the milking machines and the milk pipe.

Other researchers have come to analogous conclusions that high quality milk can be obtained by milking by robots (Schön et al., 2000; Fübbeker & Kowalewsky, 2005).

CONCLUSIONS

Using robots, cows are milked on average 2.9 times per day, coinciding with the statements of other scientists (2.5–3.0 times per day).

Of the total number of cows, 8.9% were milked four times per day, 47.3% - three times, 38.4% - two times, but 3.0% - once a day. About 3% of cows did not visit the robots voluntarily.

When 73 cows were milked by two robots, the robot load was only 64.5%. In order to load the robot to a level of 95%, the herd of cows should be increased to 110 animals.

Use of robots can result in higher quality milk than using traditional milking equipment.

REFERENCES

- Freiberger, F., Klindtworht, K., Baumeister, J., Gierse, A., Lehman, B., Ohnesorge, M., Harms, J., & Wendl, G. 2005. *Automatische Melken in modernen Milchviehställe*. KTBL, Darmstadt, 141 pp. (in German).
- Fübbeker, A. & Kowalewsky, H.H. 2005. *Praxiserfahrung mit automatischen Melksystemen*. KTBL, Darmstadt, 47 pp. (in German).
- Laurs, A. 2007. Robotic Milking in Latvia: Situation and Perspective. In Dukulis, I. (ed): *Engineering for Rural Development*. 6-th International Scientific Conference. Jelgava, pp. 377–381 (in English).
- Lind, O., Ipema, A.H., Koning, C., Mottram, T.T. & Hermann, H.-J. 2000. Automatic Milking: Reality, Challenges and Opportunities. In Hogeveen H. & Meijering A. (eds): *Robotic Milkin*. International Symposium. Lelystad, pp. 19–31 (in English).
- Muižniece, I. 2004. Milking Robots – Future Forms of Precision Milk Farming. *Agro tops* **11**, 43–45 (in Latvian).
- Schön, H. (ed). 2000. *Automatische Melksysteme*. KTBL, Darmstadt, 149 pp. (in German).