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Rational selection and usage of rotary type milking equipment

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Abstract. The advisable time of operation of the rotary type milking equipment per day depending on the specific exploitation costs has been investigated. It has been stated that these costs can be reduced, if the rotary type milking equipment load is increased. Therefore, it is advisable to organise the work of milkers in two shifts, so that the milking equipment is operated even up to 16 h per day. For this reason the herd of cows should be accordingly large. For instance, milking twice with the equipment with 50 milking places the cow herd can reach having even 2,500 cows, but at milking three times – up to 1,400 cows.

Key words: milking, rotary type equipment, milking time, exploitation costs.

INTRODUCTION

Rotary type milking equipment is widely spread in Latvia. The theoretical productivity of the equipment can reach 434 cows per hour (Mangalis & Priekulis, 2018), and therefore this equipment is suitable for large cow herds. Nevertheless, the productivity of the equipment depends on the number of milking places that are installed on the rotary platform (Kirsanov et al., 2016). The more the milking places, correspondingly increase the theoretical labour productivity of the rotary equipment. Therefore, in the largest farms at present rotary platforms with 50 and 80 milking places are used. In this case the total milking time does not exceed 6–8 hours per day. However, the productivity of the rotary platform depends also on the speed at which the animals enter and leave the rotary platform. If the number of milking places is increased, it has to be done in shorter time as the time of platform rotation is a set value (Edwards et al., 2012; Kic, 2015). To make the cow movement faster now rotary equipment with radial location of animals on the rotary platform and orientation to the central part of the rotary equipment are used. Though, our previous research shows (Mangalis & Priekulis, 2018) that such approach cannot completely solve the problem. Besides, the increased number of milking places also considerably increases the size and production costs of the milking equipment (Wagner et al., 2001).

There is another solution of this problem that is used in the large farms of the USA and Canada (Edwards et al., 2012; Edwards et al., 2013). For milking cows less productive rotary type equipment is used, considering that the total milking time should

reach 18–20 h per day. This approach essentially increases the load of the milking equipment and reduces the payback time. Besides, such rotary type milking equipment is cheaper and the problem that cows are late for milking when entering and leaving the rotary platform is also reduced. However, the milking time increases accordingly and also fatigue of people participating in milking should be taken into account.

Therefore, the aim of the present research is to state the economic efficiency of milking cows using rotary type milking equipment with reduced labour productivity in order to reach the total milking time 15–20 hours per day.

MATERIALS AND METHODS

For the research three farms in Latvia were selected, where rotary type milking equipment with 20, 50 and 80 milking places, produced by the GEA company, is used. At all of these farms the milk yield was approximately the same, i.e. ranged from 9,000 to 9,930 kg cow^{-1} year^{-1} (mean 9,477 kg cow^{-1} year^{-1}), and during milking cow mechanical movers were used, but the number of people participating in milking and the main exploitation indicators were different (Table 1).

Table 1. Description of the dairy farms includet in the research

Indicators	Milk farms		
	A	B	C
Number of milk cows	300	600	2,000
Average milk yield, kg cow^{-1} year^{-1}	9,930	9,000	9,500
Number of milking places	20	50	80
Time of one platform revolution, min revolution^{-1}	7	8	10
Preparation and finishing time before and after milking, h day^{-1}	1.0	1.5	1.67
Number of milkers in a shift	2	3	4
Number of movers in a shift	1	1	1
Wages for milkers, € month^{-1}	700	700	700
Wages for movers, € month^{-1}	500	500	500
Rotary equipment cost, €	220,000	400,000	700,000
Rotary equipment repair costs, € month^{-1}	1,500	2,000	2,500
Electric drive power, kW	8	13.5	25
Consumption of teat disinfectants, l day^{-1} cow^{-1}	0.02	0.02	0.02
Consumption of milking equipment washing detergents, l day^{-1}	3	6	10

Consumption of cold water for cow teat washing was assumed according to the recommendations (Priekulis, 2012) 0.8 L per one cow, but for milking machines – 12 L for one milking of the herd. Besides, approximately 50% of this amount is hot water with temperature 50–60 °C. In turn, for washing the floors of the milking parlour in all versions of the research it was assumed 3.5 L calculating per one cow for one milking of the herd.

Also the prices of all exploitation means (cold water, teat disinfection and milking equipment washing costs) in all cases were assumed to be equal considering the current situation on 01.11.2019.

The total milking time per day was calculated according to formula

$$t_{sl} = \frac{z_g \cdot t_c \cdot n_{sl}}{60 \cdot z_v} + n_{sl} \cdot t_{sag} \quad (1)$$

where t_{sl} – milking time, h day^{-1}; t_c – time of one rotary platform revolution, min; t_{sag} – time for preparation before milking and finishing time, h.; n_{sl} – number of milking the herd per day; z_g – total number of milk cows; z_v – number of milking places on the rotary platform.

All data necessary for the calculation were obtained in the dairy farms mentioned in Table 1, based on the results of inspecting the milking equipment and our timekeeping.

The economic efficiency of milking cows was determined according to the calculated exploitation costs (Gaworski & Leola, 2014; Gaworski et al., 2017). For this reason it was assumed that milking of cows should be done two as well as three times per day, but the size of the herd can be 250, 500, 750, 1,000, 1,250, 1,500, 1,750 and 2,000 cow correspondingly.

The calculations of the economic efficiency of milking cows included the wages for people participating in milking, milking equipment machine costs and the costs of exploitation means (consumed water, chemicals). For calculation two computer programs were prepared: one – for stating the time of milking, the other – for calculation of the exploitation costs.

RESULTS AND DISCUSSION

The milking time using the milking equipment given in Table 1 and milking two as well as three times per day is summarised in the Fig. 1.

The data presented in the Fig. 1, shows that the milking time is influenced not only by the number of cows in the herd, but also by the number of milking places on the rotary platform and the number of milkings per day. If, for instance, there are 1,000 cows in the herd and they are milked twice, then operating the rotary type equipment with 80 milking places the milking time is 7.5 h, with 50 milking places – 8.3 h, but with 20 milking places – 13.7 h per day. According to the research performed in Estonia (Reppo et al., 2007; Sada et al., 2016) the work of milkers is not to be considered in the category of physically hard work. Therefore, the shift of milkers can last

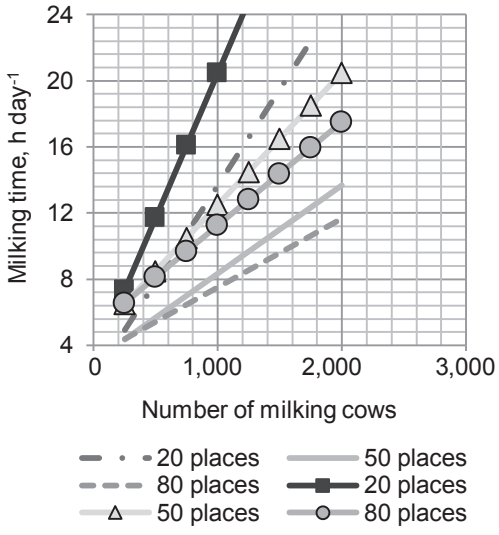

Figure 1. Milking time, h day^{-1}, depending on the number of cows, number of milking places on the rotary platform and number of milking per day (unmarked lines show milking two times per day, marked lines - milking three times per day).

for 8 h per day. It means that introducing the work in two shifts the total milking time can last for 16 h per day. Therefore, at milking twice with the equipment with 20 milking places a herd with up to 1,200 cows can be milked, but using the equipment with 50 places – approximately a herd of 2,500 cows.

If, in turn, milking is performed three times and milkers are working in two shifts, then with the rotary equipment with 20 places approximately a herd of 700 cows can be milked, with 50 places – 1,400 cows, but with 80 places – 1,750 cows correspondingly. It means that introducing the work of milkers in two shifts rotary type milking equipment with considerably reduced number of milking places can be used.

The exploitation costs of different types of rotary milking equipment depending on the number of milking times per day and the size of the herd are shown in Figs 2, 3.

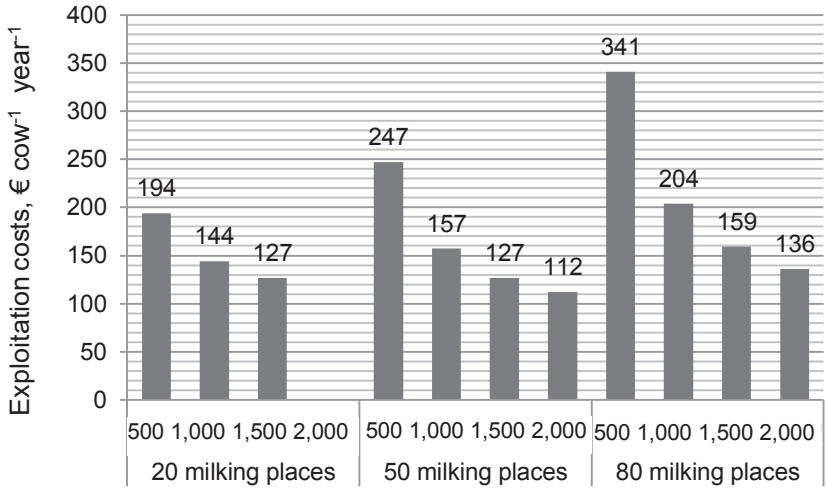

Figure 2. Exploitation costs milking twice, in € cow^{-1} year^{-1}, depending on the size of the herd (500, 1,000, 1,500 or 2,000 cows) and the number of milking places.

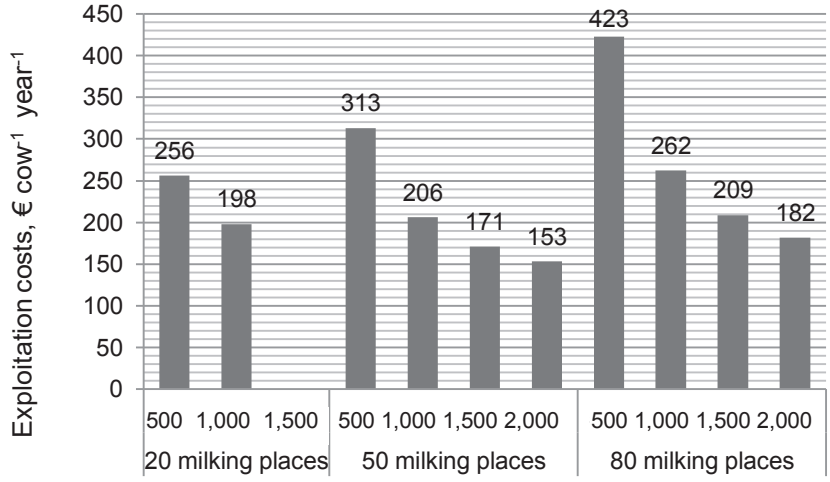

Figure 3. Exploitation costs milking three times, in € cow^{-1} year^{-1}, depending on the size of the herd (500, 1,000, 1,500 or 2,000 cows) and the number of milking places.

The data in Fig. 2 show that the exploitation costs are influenced by the size of the rotary equipment (number of milking places) as well as by the size of the herd. If, for instance, there are 1,000 cows in the herd, then milking twice and operating the rotary type equipment with 20 milking places the exploitation costs will sum up to 144 € cow^{-1} year^{-1}, operating the equipment with 50 milking places – 157 € cow^{-1} year^{-1}, but with 80 milking places already 204 € cow^{-1} year^{-1}. Besides, it is essential to use the milking equipment for milking a possibly larger herd. The research results shown in the Fig. 2 demonstrate that increasing the herd by a step corresponding to 500 animals the exploitation costs reduce by 40–12%. Therefore, it is advisable to choose the milking equipment that can ensure operation of a possibly large herd without exceeding the limited working time of the milkers (8 h).

A similar situation can be seen also in Fig. 3. Though, in this case the milking time of the herds has increased (by 1.5 times per day), and therefore the corresponding exploitation costs become higher. Besides, the equipment with 20 milking places cannot be used for herds with 1,500 cows as in this case the working time for milkers exceeds 24 h per day.

The relationship between the specific costs of milking and the total milking time is shown in Fig. 4. According to the formula (1) it is possible to calculate that in the farm B, where there are 600 cows and they are milked twice, the total milking time is 6.2 h per day. In turn, (Fig. 4) shows that in this case the specific exploitation costs are about 200 € cow^{-1} year^{-1}. If the size of the herd is increased up to 2,250 cows, the total milking time increases up to 15 h per day, but the specific costs reduce up to 107 € cow^{-1} year^{-1}. It is almost two times difference.

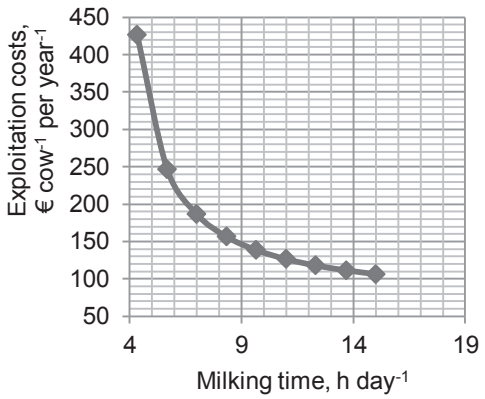

Figure 4. Variations of milking specific exploitation costs depending on the total milking time, if rotary equipment with 50 milking places is operated and cows are milked twice a day.

CONCLUSIONS

It is rational to introduce two working shifts for milkers and to ensure that the rotary type equipment is operated even up to 16 h per day. If the cows are milked twice per day, then at the above mentioned preconditions the rotary equipment with 20 milking places can serve a herd up to 1,200 cows, but with 50 milking places – a herd with approximately 2,150 cows. If, in turn, the cows are milked three times, then the rotary type milking equipment with 20 milking places is suitable for milking up to 700 cows, with 50 milking places – for a herd with up to 1,400 cows, but with 80 milking places – for a herd with up to 1,750 cows.

The specific costs of rotary type milking equipment in € per cow per year, are essentially dependent on the size of the cow herd. When bigger number of the cows to be milked, it is possible to expect the smaller costs correspondingly. If, for instance, in the result of increasing the number of cows the total milking time changes from 6 to 16 hours per day, the specific exploitation costs for milking reduce in double amount.

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