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Cow crowding in waiting yard using mechanical drivers and its influence on productivity of rotary type milking equipment

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Abstract. At present rotary type milking equipment is popular in Latvia. It is used almost on all farms where there are 400 and more cows. Nevertheless, the maximal productivity of work can be reached if the cows are continuously driven from the waiting yard to the milking equipment and if sufficient intensity of animal traffic is ensured. Therefore, the rotary type milking equipment is usually supplemented with a mechanical cow driver that crowds the cows in the waiting yard at the same time driving them towards the milking parlour.In the research it has been stated that using the heavy type mechanical cow drivers Cow Mander 640 or Cow Mander 740 the maximal cow crowding in the waiting yard reaches 1.1–1.2 m^2 calculating per one cow and it ensures the cow traffic intensity 8–11 s cow^{-1}. If, in turn, the medium heavy driver Cow Mander 015 is used, the cow crowding is only 1.5–1.7 m^2 cow^{-1} and the cow traffic intensity reaches 15–23 s cow^{-1}. Using rotary type milking equipment with 20–30 milking places such cow traffic intensity is sufficient but if the rotary milking equipment has 50 and more milking places the necessary cow traffic intensity cannot any more be ensured by increasing the cow crowding. Therefore, the exploitation work productivity of the rotary type milking equipment with 50 and more places is by 30–40% less than its technological productivity of work that is obtained by means of calculations.

Key words: cow crowding, cow traffic intensity, mechanical cow drivers, productivity of work, rotary type milking equipment.

INTRODUCTION

In Latvia application of rotary type milking equipment develops fast. It is used almost on all large farms that have been built in Latvia in recent years. Besides, equipment with side-by-side (abreast) location of cows during milking is especially popular. The economic profitability of application of this equipment is confirmed also by our research that proves that usage of rotary type milking equipment becomes economically profitable if the size of the herd exceeds 300–400 milk cows (Priekulis & Kurgs, 2010).

Nevertheless, the productivity of this milking equipment depends on two independent factors: the productivity of the corresponding milking equipment and the intensity of cow traffic entering the rotary parlour platform. It is because in an ideal case the rotary type milking equipment platform rotates with a definite speed during milking but in a definite moment of time or during the so called limit time replacement of cows should be ensured – every milked cow should leave the rotary equipment platform but the cow to be milked should manage to occupy its place in due time. If replacement of cows is delayed the rotation speed of the platform has to be reduced or it has to be stopped for a while. But it reduces the productivity of the milking equipment.

In order to fasten the cow traffic entering the rotary platform today cow mechanical drivers are used (Mangalis, 2014) that crowd the cows in the waiting yard ensuring their continuous movement to the milking equipment.

The aim of the present research is to state to what extent cow crowding in the waiting yard influences their traffic speed entering the rotary type milking equipment platform and how it changes the rotary type milking equipment productivity.

MATERIALS AND METHODS

Seven milk farms in which cow mechanical drivers and rotary type milking equipment are used were selected for the research. On all farms included in the research the cows were handled in cold barns using recreation boxes, and the cows were milked three times a day. But the size of the herd and types of rotary milking equipment, planning of the farms and organization of work in milking were different on these farms. The most important data characterizing every of the farms included in the research are summarized in Table 1.

Table 1. Characterisation of farms included in the research

Specification	Farms						
	A	B	C	D	E	F	G
Number of cows in herd	300	670	390	600	575	1055	816
Company producing milking equipment	GEA Farm Tehnologies	GEA Farm Tehnologies	GEA Farm Tehnologies	GEA Farm Tehnologies	DeLa-val	GEA Farm Tehnologies	GEA Farm Tehnologies
Applied milking equipment	Rotary milking herringbone Systems-20	Rotary milking herringbone Systems-32	Rotary milking herringbone Systems-36	Rotary milking Side-by-Side Systems-50	Rotary milking PR-50	Rotary milking Side-by-Side Systems-60	Rotary milking Side-by-Side Systems-80
Number of milking places	20	32	36	50	50	60	80
Applied cow mechanical driver	Cow Mander 015	Cow Mander 640	Cow Mander 640	Cow Mander 640	HRS Herdsmann	Cow Mander 600/700	Cow Mander 740
Number of milkers	2	2	2	2	3	4	4
Number of drivers	1	1	1	2	1	1	2

Cow crowding in the waiting yard and the intensity or rhythm of cow traffic were stated experimentally during the research on the farms given in Table 1. For this reason the distance along which the mechanical cow driver moved during milking was stated after every 10 cows entered the milking equipment.

For calculation of the average cow crowding the following formula was used.

$$\Delta = \frac{b_l \cdot (s_1 + s_2 + ... + s_x)}{z_g \cdot x} \qquad (1)$$

where: Δ – average cow crowding in the waiting yard considering the part of the yard occupied by one animal, m^2 cow^{-1}; b_l – width of the waiting yard, m; s_1; s_2; s_x – distance or step along which the mechanical cow driver moves during the first, second and n period of the research, m; z_g – number of cows that entered the milking equipment in the corresponding period of the research (in our research $z_g = 10$ cows); x – total number of research periods.

In order to state the cow traffic rhythm the time was stated that is necessary for milking every 10 cows, i.e., for implementation of one research period, and it was stated registering the time intervals in which groups of 10 cows entered the milking parlour. After that the average cow traffic rhythm was calculated using the following formula.

$$t_{virz} = \frac{\sum^{n} t_{gr}}{\sum^{n} z_{gr}} \qquad (2)$$

where: t_{virz} – average cow traffic rhythm, s cow^{-1}; t_{gr} – length of milking every cow, s; n – number of cow groups.

For testing the validity of the calculated results the mathematical statistics methods described in literature were used (Arhipova & Bāliņa, 2003).

Using the experimental research results and information given in literature the milking equipment limit time, technological productivity as well as productivity of the milking equipment operation W_{eks} were stated.

The limit time characterizes the period of time during which the milking equipment moves along one milking place and it is calculated according to the formula.

$$t_{\lim} = \frac{T_c}{n_{ap}} \qquad (3)$$

where: t_{lim} – limit time, s; T_c – length of one milking cycle (equal to the length of one rotary platform revolution), s; n_{ap} – number of milking machines or milking places on the rotary platform, pcs.

Length of one milking cycle (Priekulis et al., 2012)

$$T_c = t_{ieie} + t_o + t_{ap} + kt_{ap} + t_{izie} \quad (4)$$

where: t_{ieie} – time for a cow to enter the rotary type milking equipment, s; t_o – average length of milkers' working operations per one cow (includes the time consumed for preparation of the cow before milking and application of the milking machine), s; t_{ap} – average milking length of one cow, s; t_{izie} – time spent for one cow to leave the rotary platform, s; k – milking length margin coefficient (includes the possible increase of the milking length compared to the average milking length, it is recommended to assume that k = 0,5 (Priekulis et al., 2012, Timšāns et al., 1974).

Technological productivity of the equipment can be calculated according to the following formula:

$$W_{teh} = \frac{3600 \cdot n_{ap}}{T_c} = \frac{3600}{t_{\lim}} \quad (5)$$

where W_{teh} – technological productivity of the equipment, cows h^{-1}.

Productivity of the milking equipment operation

$$W_{eks} = \frac{3600}{t_{virz}} \quad (6)$$

where W_{eks} – productivity, cows h^{-1}.

Coefficient of the productivity of the milking equipment operation

$$k_{eks} = \frac{W_{eks}}{W_{teh}} \quad (7)$$

RESULTS AND DISCUSSION

The experimental researc data and the calculation results are summarised in a joint Table 2.

The dynamics of the cow traffic stated in the experiments is shown in Fig. 1. It can be seen that this intensity depends on the kind of the cow driver and partly also on the correspondence of the people engaged in cow driving to the number of the cows to be milked.

Table 2. Summary of the research results and calculations

Indices	Farms						
	A	B	C	D	E	F	G
Number of milking places	20	32	36	50	50	60	80
Crowding of cows, m^2 cow^{-1}	1.7	1.24	135	1.2	1.45	1.5	1.1
Cow traffic rhythm, s cow^{-1}	24.0	14.3	17.3	14.0	16.1	13.5	9.3
Limit time, s cow^{-1}	24.90	15.56	13.83	9.98	9.98	8.30	6.23
Technological productivity of the equipment, cows h^{-1}	145	231	260	361	361	434	578
Productivity of the milking equipment application, cows h^{-1}	150	252	208	257	224	266	387
Coefficient of the productivity of the milking equipment application	1.03	1.09	0.80	0.71	0.62	0.61	0.67

Working in automatic regime the cow mechanical drivers Cow Mander 640 and Cow Mander 740 (Priekulis & Kurgs, 2010) can ensure that cow crowding in the waiting yard reaches 1.1–1.2 m^2 calculating per one animal. Nevertheless, it considerably exceeds the cow crowding recommended in literature 1.5–1.6 m^2 cow^{-1}. Therefore, on many farms the average cow crowding is 1.4–1.7 m^2 cow^{-1}.

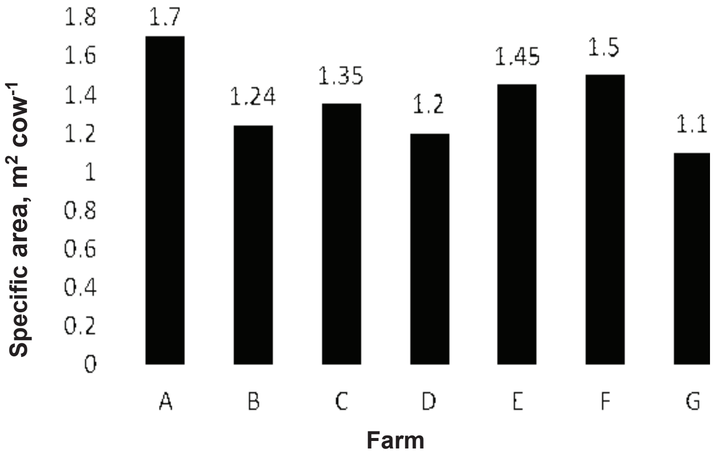

Figure 1. Cow crowding in the waiting yard using mechanical driver, m^2 cow^{-1}.

The influence of animal crowding on the intensity or rhythm of cow traffic is shown in Fig. 2. According to this it can be stated that if the crowding increases the cow traffic intensity has a tendency to increase.

But our observations prove that excess cow crowding promotes occurrence of stressful situations (Maton et al., 1985) when the cows are entering the rotary type milking equipment. It can cause situations that two cows are trying to occupy the milking place at the milking equipment entrance. But it causes jamming and a necessity to stop the rotary equipment as the cows have to be driven back. Therefore, in such cases the milkers are disturbed from doing their direct duties and the total length of milking cows increases.

It should be noted that using the heavy mechanical cow driver Cow Mander 015 cow crowding in the waiting yard does not exceed 1.6–1.7 m^2 cow^{-1}, but it is enough for ensuring the necessary traffic of cows if the rotary milking equipment has 20 milking places.

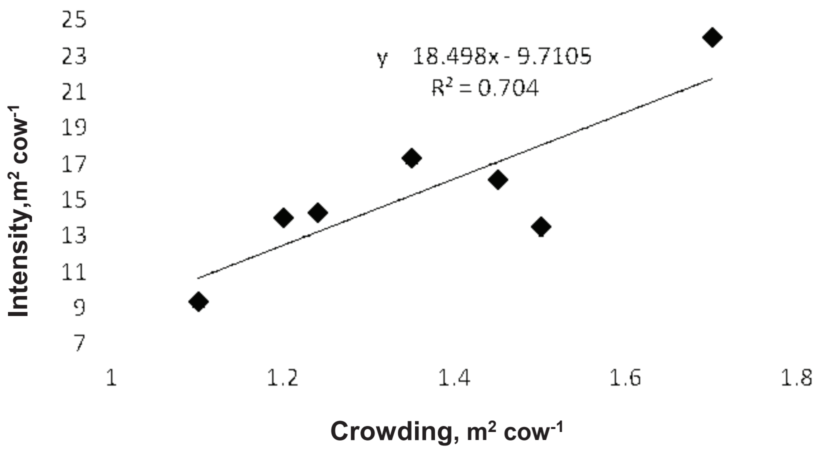

Figure 2. Changes of cow traffic intensity from the waiting yard to the rotary platform depending on the cow crowding in the waiting yard.

The cow traffic intensity is related to the milking equipment limit time. The bigger the number of the rotary equipment milking places, the less becomes the limit time, i.e., the interval of time in which the cow has to enter the rotary platform. If, for instance, the rotary type milking equipment has 20 milking places, the limit time is 24.9 s cow^{-1}, if there are 50 places, then 9.98 s cow^{-1}, but if 80 places, then only 6.23 s cow^{-1}.

In turn, our research shows that for rotary type milking equipment with 20–30 milking places the cow traffic intensity approximately corresponds to the limit time or even a little exceeds it (Table 2). But if there are more milking places, the cow traffic intensity starts to lack behind the limit time. It means that the cows cannot manage to occupy their place fast enough on the rotary platform so reducing the potential productivity of the milking equipment.

This situation is clearly shown in Fig. 3 which depicts the productivity of rotary type milking equipment depending on the number of milking places.

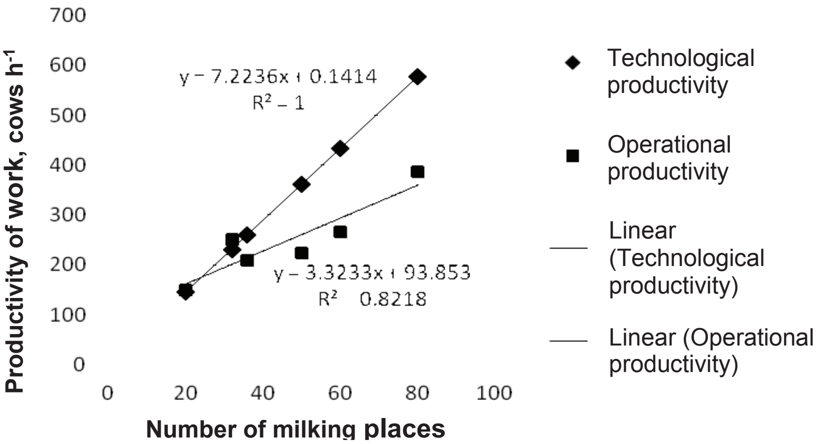

Figure 3. Technological and operational productivity of rotary type milking equipment depending on the number of milking places.

It can be judged from the figure that for rotary type milking equipment the operational productivity of work approximately corresponds to its technological productivity that is obtained by calculations. If the number of milking places is higher the operational productivity of work starts to lack behind the technological productivity as it is caused by lacking of the cow traffic intensity behind the limit time. This is surely dependent upon several factors: specifics of application of machinery (construction and the set operation regime of the cow mechanical driver, rotary equipment rotation speed), specifics of the cow herd (length of milking separate cows, character and health of the cows) as well as organization of work, (Brunsch et al., 1996), resourcefulness and skills of the people engaged in milking. Therefore, on every farm included in the research this difference between the technological and operational productivity was different. But for practical needs it can be considered that for rotary type milking equipment with 50 and more milking places the operational productivity coefficient is 0.6–0.7.

CONCLUSIONS

Cow crowding in the waiting yard influences the intensity of animal traffic to milking. If, for instance, the crowding is 1.1–1.2 m^2, calculated per one animal, the traffic intensity reaches 9–13 s cow^{-1}, but if the crowding is 1.5–1.7 m^2 cow^{-1}, then 15–23 s cow^{-1}.

The maximal animal crowding can be achieved if the heavy type cow mechanical drivers Cow Mander 640 or Cow Mander 740 are used. If, in turn, the medium heavy driver Cow Mander 015 is used, the cow crowding is only 1.5–1.7 m^2 cow^{-1} and the intensity of cow traffic reaches 123 s cow^{-1}.

To achieve correspondence of the milking equipment operational productivity with its potential resources the intensity of cow traffic from the waiting yard to the milking equipment should correspond to the calculated limit time, i.e., the period of time in which the rotary equipment moves ahead one milking place. If the rotary type milking equipment has 20–30 milking places, the necessary cow traffic intensity or the limit time is 15–25 s cow^{-1} that can be ensured with medium heavy cow mechanical drivers, but if the rotary type milking equipment has more milking places, the cow traffic intensity starts to lack behind the limit time that reduces the operational productivity of the rotary type milking equipment.

For rotary type milking equipment with 50 and more milking places the coefficient of operational productivity is 0.6–0.7.

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