PREPARATION AND DISTRIBUTION OF FORAGE MIX USING MOBILE MACHINERY

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Abstract. Preparation and distribution of forage mix using mobile machinery on four Latvian farms where there are 200 to 430 milk cows have been investigated. For this purpose timekeeping of forage mix preparation and distribution was done and the obtained data were processed. Considering that the situation on every farm is different the processed data were transformed to three assumed farms where 100, 300 and 500 cows can be handled. In the research the most suitable technological versions of forage mix preparation and distribution were determined. It was stated that on every farm with 100-300 cows one of the most suitable technologies is the forage mix preparation and distribution technology applied in the company "Agro Kaķenieki" where for loading of feed a scoop with passive knives is used, but for distribution – a mobile mixer *DeLaval-16*. Bothe machines are operated by one worker accordingly changing the machinery units. In turn, in barns with 500 cows it is advisable to use a mixer-distributor of self-propelling type *Siloking Prestige* as it compared to other technological versions ensures time consumption by 12-32 % and work consumption 1.3-2.2 times calculated per ton of the distributed feed.

Key words: cow, feed, mobile feed distributors, speed of machines, specific costs.

Introduction

Distribution of feed in barns is a difficult and responsible job of which the productivity and health of animals depend. At present mainly mobile feed distributors or distributors-mixers operated by tractors are used. Their advantage is that with such machines supply of feed to the animal stalls as well as its mechanized distribution are possible.

Today different kinds of mobile feed distributors are offered that differ in their construction, capacity, aggregating properties etc. [1]. Also the feed loading solutions, technological versions of distribution and organization of work can differ. Besides, the desired solution of feed distribution should be in compliance with the number of animals in the barn as, according to the previous investigations of different authors [2; 3], at a larger number of animals it is profitable to introduce more productive and expensive equipment.

Therefore, the aim of the present research was too deeply analyse the most characteristic solutions of feed distribution using mobile feed distributors and to evaluate their economic usefulness for cow farms of different sizes.

Materials and methods

The research was performed on four Latvian farms with 200-430 milk cows where feed is distributed with mobile machinery (Table 1). The research was carried out in the period from 2009 to 2011.

Table 1

Characterisation of experimental farms

Name and location of the farm	Number of milk cows	Feed loading equipment	Feed distribution equipment
TRF "Vecauce", Dobele region	380	*MTZ 82* and loading forks + concentrated feed spiral conveyor	*Strautmann* with 2 vertical screws
Company "Agro Kaķenieki", Dobele region	280	*New Holand 95* and a scoop with passive knives	*DeLaval-16* with 3 horizontal screws
Farm "Meža Cīruļi", Jelgava region, Glūda village	203	*John Deere-5400* and a scoop with passive knives	*JFPA-12* with horizontal mixing shaft
Farm "Kalna Dambrāni", Jēkabpils region, Viesīte village	430	*Siloking Prestige*, self-loading and self-propelling mixer-distributor	

On these farms the present situation was stated (the number of cattle and feed rations in separate feeding groups, planning of the farm with mobile distributor moving routes, the length of the routes, machinery used for preparation and distribution of feed) and timekeeping of feed distribution was done dividing the process of work in separate operations and stating the length of every operation. To get the necessary veracity, timekeeping of feed distribution was done for five feeding times, and for further calculation the average data were used.

Processing the timekeeping results information was obtained on the length of feed loading, speed of moving of the mobile machines (with load and idle), length of feed distribution etc.

Considering that the situation is different on every farm included in the research the processed data were transformed to the three assumed farms where 100, 300 and 500 cows can be handled. For transformation the following methods were applied:

- For every size of the farm a situation plan and the barn plan were developed considering the number of cows. One example of such planning for 300 cows is given in Figure 1.
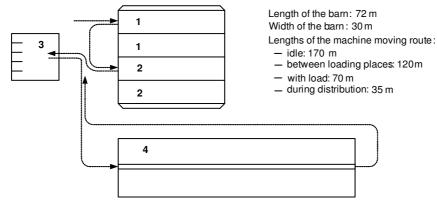

Length of the barn: 72 m
Width of the barn: 30 m
Lengths of the machine moving route:
— idle: 170 m
— between loading places: 120 m
— with load: 70 m
— during distribution: 35 m

Fig. 1. **Planning of a farm for 300 cows (interrupted lines show the moving routes of feed distribution machines:** 1 – grass silage trenches; 2 - corn silage trenches; 3 – concentrated feed loading area with feed bins; 4 – cow barn

- The cows are distributed into two milk yield groups: with 8000 kg and 6000 kg. For every of these groups the corresponding feed ration and kinds of feed are determined, calculating per one day [4] (Table 2).
- Calculating the content of feed mix it is assumed that 75 % of the total numbers of cows belong to the high productive group but 25 % to the less productive group.
- The length of the corresponding technological operations is recalculated for every of the assumed size farms considering that for feed distribution the technology as on the experimental farms is used, and feed is distributed twice a day.
- The specific costs of feed distribution are calculated using the methods given in literature [2; 3] and developing a corresponding software.
- The research results are processed constructing corresponding graphs for this purpose and giving a comparative evaluation of the feed distribution technologies.

Table 2

Feed rations and their structure

Kinds of feed	High productive group	Less productive group
Grass silage	18	12
Corn silage	9	10
Barley flour	5.0	3.0
Corn flour	1.0	-
Rape meal	3.0	2.0
Mineral premix	0.1	0.05
Salt	0.07	0.02
Forage chalk	0.08	-

Research results

Processing the timekeeping data it turned out that on every experimental farm the number of workers, the productivity of feed loading and the moving speed of feed distribution equipment are different.

Table 3

Results of timekeeping of feed distribution versions

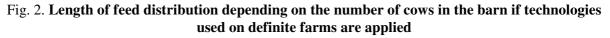| Farm	Number of people working at distribution	Average productivity of feed loading, t·h^{-1}		Average speed of machines, km·h^{-1}	
		concentrated feed	concentrated feed	one passage	distribution
Farm "Kalna Dambrāni"	1	12.8	17.5	6.2	1.21
Farm "Meža Cīruļi"	2	17.3	3.9	5.2	0.87
TRF "Vecauce"	2	45.6	4.2	5.3	0.61
Company "Agro Kaķenieki"	1	11.4	6.6	4.9	0.49

The timekeeping data show that loading silage prepared in the trenches the productivity of work for different technological versions has been in the range from 11.4 to 17.3 t·h^{-1}. An exception is the training and research farm "Vecauce" where the productivity of work reached 45.6 t·h^{-1}. It is because in "Vecauce" silage loading forks are used that do not have knives and therefore the feed is pulled out from the pile in big pieces. Still, such kind of loading is not recommended as it promotes perishability of the left silage [5].

The productivity of silage loading has been mainly from 3.9 to 6.6 t·h^{-1}. Here the technology of the farm "Kalna Dambrāni" stands out where the productivity reached 17.5 t·h^{-1}. It can be explained by using a self-propelled machine that can load the silage independently taking it from the common pile.

The average moving speed of the feed distribution machine during one passage was in the range from 4.9 to 6.2 km·h^{-1}, but during the feed distribution - from 0.49 to 1.21 km·h^{-1}. Also in this case the highest speed has been stated on the farm "Kalna Dambrāni" where for distribution of feed a self-propelling machine was used.

The length of feed distribution that was obtained transforming the timekeeping results to the farms with the assumed number of animals 100, 300 and 500 can be seen in Figure 2.

Fig. 2. **Length of feed distribution depending on the number of cows in the barn if technologies used on definite farms are applied**

The figure shows that if the number of cows increases also the length of feed distribution increases. It is related to a larger amount of the distributed feed and the length of the routs of the machines. If, for instance, handling 100 cows the length of the route in one distribution cycle is approximately 310 m, then handling 300 and 500 cows this length is accordingly 390 and 490 m.

The length of feed distribution depends also on the technological version. It is influenced by the length of loading of separate kinds of feed as well as by feed mixing time, the machine speed during feed transportation and distribution, and also by idle runs. The present research shows that the shortest length is if a self-propelling machine (technological version on the farm "Kalna Dambrāni") is used. In such case the time of one feed distribution cycle was even 1.4 times less than in the other versions included in the research.

If the specific time consumption of feed distribution is mutually compared (Fig. 3) it can be seen that also in this case the self-propelled feed distribution machine is better. The second place is occupied by technological version of the company "Agro Kaķenieki", the peculiarity of which is the fact that all working operations are done by one person working as a loader and as a distributor if needed.
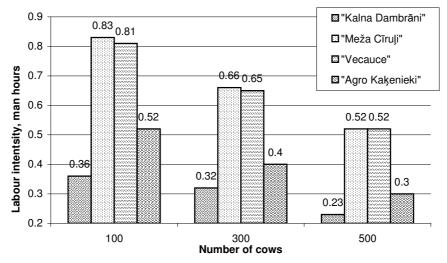

Fig. 3. **Specific labour intensity of feed distribution depending on the number of animals in barn if technologies used on definite farms are applied**

Following the standpoint of the economic profitability evaluation of different versions of feed distribution according to the specific costs has the greatest importance (Fig. 4).
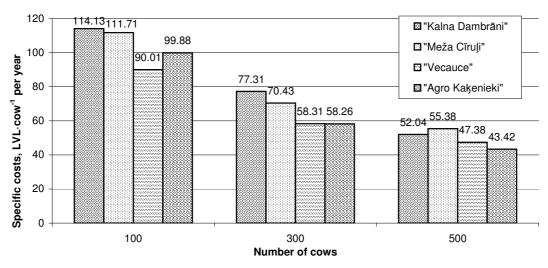

Fig. 4. **Feed distribution specific costs depending on number of animals in barn if technologies used on definite farms are applied**

The figure shows that the feed distribution specific costs, LVL·cow^{-1} per year, are most influenced by the number of cows on the farm. If there are more cows, the costs are less. Still it should be noted that such trend is not new as it has been stated also in other similar investigations [2].

These costs depend also on the applied technology. If 100 cows are handled, the technology used on the TRF "Vecauce" is cheaper. Still, on that farm silage is loaded by a frontal loader with forks and due to this the feed left in the trench gets loose. Therefore, according to this opinion it is more profitable to use the technology of the company "Agro Kaķenieki" where the feed loader and distributor are served by one person. This technology is more suitable also in the case if 300 and 500 cows are handled. Figure 4 shows also that if the number of cows increases the specific costs of the self-propelled machine decrease especially fast. Therefore it is possible to prognosticate that handling 800 and more cows this could become the most economically profitable solution of feed distribution. Still, this hypothesis needs to be investigated in out future research.

Conclusions

1. The labour intensity of silage loaders is 11.4 to 17.3 t·h^{-1}. An exception is the TRF "Vecauce" where it reached 45.6 t·h^{-1}. But in this case smooth feed removal surface was not ensured as it was loaded by forks attached to the frontal loader.
2. The capacity of silage loading is in the range of 3.9 to 6.6 t·h^{-1}. Only on the farm "Kalna Dambrāni" it was higher – 17.5 t·h^{-1}. On this farm a self-propelled feed distributor was used what ensures independent loading of silage.
3. The average speed of distributing machines is in the range from 4.9 to 6.2 km·h^{-1}, but during distribution of feed – from 0.49 to 1.21 km·h^{-1}.
4. If there are 100 to 300 cows on the farm, one of the most suitable technologies is the feed distribution technology used in the company "Agro Kaķenieki", as it has comparatively less work consumption and small specific costs. In turn, in barns with 500 cows also the technology used on the farm "Kalna Dambrāni" can be suitable as in this case there is the shortest time of feed distribution, specific labour intensity and also the specific costs are smaller.

References

1. Lopbarības smalcinātāji, maisītāji un izdalītāji. Journal "AgroTops", 2010.g.septembris 36-38. lpp. (In Latvian).
2. Priekulis J. Racionāla tehnoloģija un mehanizācija piena lopkopībā. Jelgava: LLU, 2000. 148 lpp. (In Latvian).
3. Lauksaimniecības darbu mehanizācijas ekonomiskais vērtējums./ Sast. J.Priekulis, N. Strautnieks. Jelgava: LLU, 2000. 29 lpp. (In Latvian)
4. Spiekers H., Menke A. Milchviehfütterung heute. -Bonn: aid e.V., 2000. 57 S. (In German).
5. Gerighausen H. Technik der Grobfuttervorlage. Journal "BauBriefe Landwirtschaft" vol. 44. Landwirtschaftsverlag GmbH, Münster-Hiltrup, 2004. 22.-24.S. (In German).