ECONOMIC EVALUATION OF ANIMAL FEED MIX DISTRIBUTION TECHNOLOGIES

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Abstract. Preparation and distribution of animal feed mix on four Latvian farms where mobile machinery is used are researched. The technologies are evaluated according to the specific work capacity and specific exploitation costs. For the research a corresponding mathematical model has been developed using the computer simulation program MatLab Simmulink. It has been stated that it is more profitable to use technologies when all working operations are performed by one worker. If two workers are involved in preparation and distribution of animal feed (drivers of mobile aggregates), the specific consumption of work increases two times, but the specific costs by 30 – 50 %. If the size of the herd exceeds 373 cows, it is rational to use self-propelling animal feed preparation and distribution aggregate.

Key words: feeding cows, animal feed mix, mobile animal feed distributor, economic evaluation.

Introduction

On milk farms animal feed mixtures that are fed at the feeding table or animal feed bunks are widely used. For preparation and distribution of such feed mobile animal feed mixers-distributors are used.

Compared to analogous stationary machinery the mobile animal feed mixers-distributors have several advantages.

- Mobile machinery ensures preparation and distribution operations using one and the same aggregate, including also transportation of separate feed materials from their storages, but sometimes also self-loading.
- Usually such machinery can prepare mealy feed mix not only from previously cut mass but also from pressed preserved grass animal feed rolls and bales as the working parts of the mixers are equipped with knives.
- With one and the same aggregate animal feed can be distributed in several animal barns.
- If there are any mobile machinery refusals and repair is needed, it can be replaced by a similar mobile machine.

Still, the mobile animal feed mixers-distributors are of different constructive kinds, also on every farm a different solution of their application is used as it depends on many factors: the size of the herd, physical-mechanical properties of the mixture components, the kind of their loading in the mixer, aggregate completion and productivity of work, distance for transportation of feed etc.

Therefore, the aim of the present research is to compare the most characteristic technological versions of animal feed preparation and distribution using mobile aggregates. The first such research was performed last year [1] comparing the technological solutions used on several farms. The present article describes developed research methods to obtain discrete research results depending on the size of the herd.

Materials and methods

The research has been done on six farms where the size of the herd is from 200 to 430 cows. On all of these farms preparation and distribution of animal feed mix is done with mobile animal feed mixers-distributors. For further research four farms were selected where different animal feed mix preparation and distribution technologies are used.

On farm A a tractor traction mixer-distributor DeLaval-16 with three horizontal screws aggregated by the tractor NewHoland 95 is used. There is also a scoop with passive knives attached to the tractor that is used for cutting the preserved grass animal feed from the heap in the trench. During loading the preserved feed the tractor is separated from the distributor but before moving to another place it is attached again. All this work is done by one worker.

On farm B all preparation and distribution of animal feed mix operations are performed by one self-propelled type mixer-distributor Siloking Prestige that is self-loading as it is supplied with a

loading cutter. This cutter is used for loading preserved grass feed as well as concentrated feed taking it from the heap.

On farm C a mobile animal feed mixers-distributor JFPA-12 with a horizontal mixing shaft aggregated by the tractor John Deere-5400 is used but for loading preserved feed from the trench the tractor John Deere 3400 with a telescopic boom with a scoop and passive knives is used. Every tractor aggregate is operated by a separate worker.

On farm D animal feed mix is prepared and distributed with a tractor aggregate consisting of the tractor Case IH JX 95 and a mixer-distributor Strautmann having two vertical screws. For loading preserved grass feed from the trenches the tractor MTZ 82 is used that is assembled with forks but for loading concentrated feed from the bunker and feeding into the mixer a spiral transporter is used. Also on this farm every tractor aggregate is operated by a separate worker.

For comparison of the technological versions a special mathematical model was developed that operates in the computer simulation program MatLab Simmulink environment. In this model the main input data are the number of cows and parameters of every technological version: the used machinery, number of people working, length of loading, mixing and transporting of every kind of feed, consumption of fuel and prices, payment for work etc. For development of the machine cost mathematical model the methods available in literature are applied [2; 3].

Considering that the initial data are obtained from milk farms with different sizes of herds, aggregate movement distances, amount of feed etc., the below mentioned assumptions as well as additional mathematical correlations relating separate initial data were elaborated.

- On all farms the cows are dividend in four feeding groups according to the milk yield. It has been assumed that for the most productive group the milk yield is 8000 $kg \cdot year^{-1}$ but for the less productive – 6000 $kg \cdot year^{-1}$. For every feeding group feed rations are different that have been calculated considering this yield.
- In the most productive group there is 75 % of the total number of cows but the less productive group includes 25 % of the herd.
- In simulation the number of cows was changed from 51 – 600 animals.
- Feed is prepared and distributed twice a day.
- The capacity of the hitched feed mixers-distributors is 2.5 t but of the self-propelled aggregate – 5.0 t.
- Payment for the workers is calculated according to the normative 2.5 $LVL \cdot h^{-1}$.
- The productivity of work of the feed loading machinery was calculated using the timekeeping data.
- The universal machinery used for distribution of animal feed, for instance, animal feed loading tractor aggregates are used also for other operations.
- The time necessary for mixing feed is 6 min, but for distribution 3 min (it corresponds to the average timekeeping data). In turn, the length of the distance of the feed distribution aggregate depends on the number of cows on the farm and it is calculated according to the corresponding mathematical correlation.
- The machinery exploitation coefficients evaluating the additional operations working with mobile aggregates are obtained from the timekeeping data and are as follows: for technology A = 1.4; B = 1.05; C = 1.15 and D = 1.2.

In the result of the calculations the specific work capacity, manh per one ton of the distributed animal feed, and the specific exploitation costs for feed preparation and distribution technological lines, $LVL \cdot cow^{-1}$ per year were calculated.

Results and discussion

The research results obtained according to the data and calculations summarised on farms and implemented with the mathematical model n the simulation computer program MatLab Simmulink are reflected in figures.

Figure 1 shows that the specific consumption of work changes depending on the number of cows. The bigger it is, the more the consumption of work decreases. But at a definite number of cows fast

increase of the consumption of work can be observed. It is because in our initial data the capacity of the mixer is assumed 2.5 t. With gradual increase of the number of cows such mixer capacity becomes insufficient for distributing the mixture with one transport aggregate run to the more productive group of cows. Therefore, to distribute feed to the more productive group at the size of the herd 187 cows two runs are necessary, for 373 cows – three runs and 559 cows – four runs. But every increase of the number of runs causes the increase in the consumption of work.

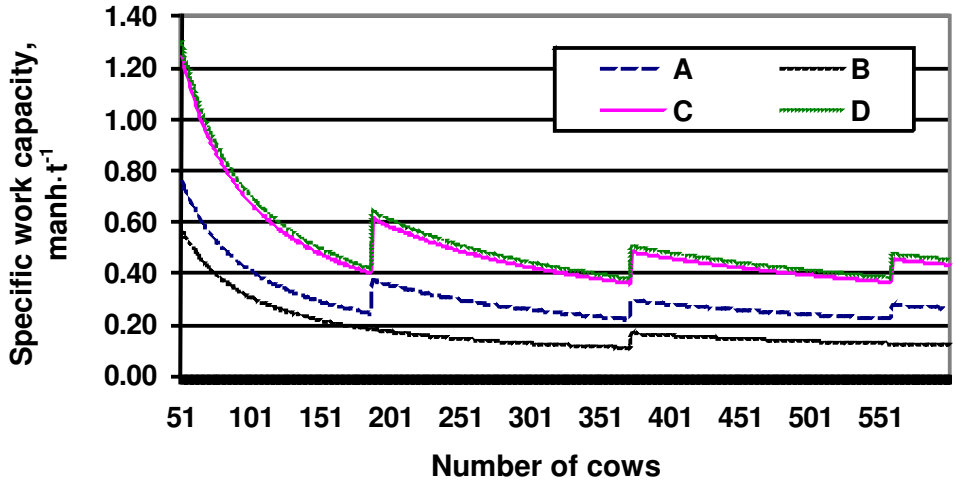

Fig. 1. **Specific consumption of work for preparation and distribution of animal feed mix, manh·t^{-1}, depending on the number of cows and technological solution**

The figure also shows that the least specific consumption of work is with feed preparation technologies that are used on farms A and B. It is because on these farms all operations are done by one person. In turn, for the technologies that are used on farms C and D the silage loader is served by an additional worker and therefore the specific consumption of work on these farms is approximately the same.

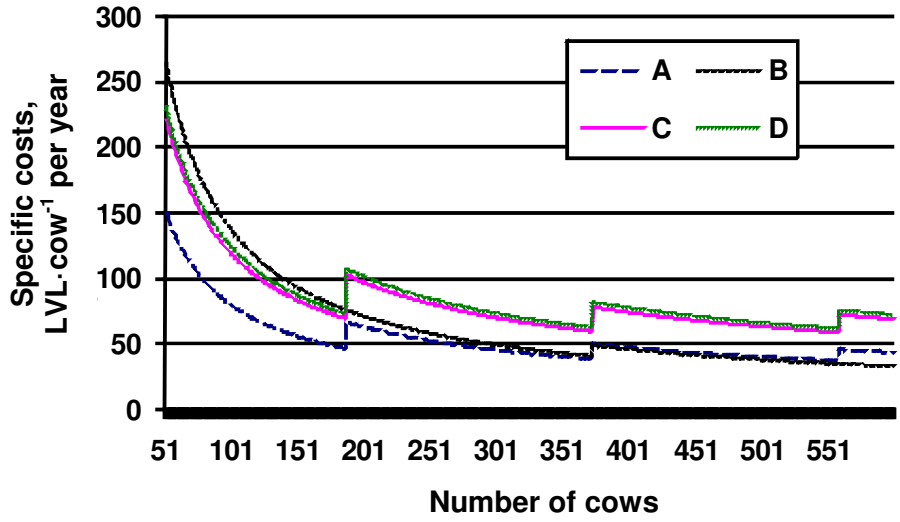

Fig. 2. **Animal feed preparation and distribution specific costs, LVL·cow^{-1} per year, depending on the number of cows on the farm and the technological solution used**

Figure 2 shows that the specific costs of animal feed preparation and distribution change correspondingly to the curves of the consumption of work. But the mutual location of the curves is different.

In this case at the size of the herd 373 cows the curves A and B are crossing. By this point the least specific costs are for the technology that is used on farm A, but after that – the technology used

on farm B. It proves that considering the specific costs as well as the specific consumption of work the technologies where all work is performed by one person are economically more profitable. Beside, on farms where the size of the herd does not exceed 373 cows it is economical to use the technological version A. But if the size of the herd exceeds 373 cows it is more economical to use the self-propelled type animal feed mix preparation and distribution aggregate (technology B).

If, in turn, the technologies C or D are used, then compared to the above mentioned rational solutions the specific costs increase by 30 – 50 %.

Conclusions

1. For preparation and distribution of animal feed mix it is desirable to use technologies where all work operations are performed by one worker. If in preparation and distribution of animal feed mix two people are involved (operators of mobile aggregates) the specific consumption of work increases two times but the specific exploitation costs by 30 – 50 %.
2. If the size of the herd does not exceed 373 cows it is economical to use the technology used on farm A where the work is performed by one tractor aggregate with a scoop for loading silage in the front but in the rear the feed mixer distributor is attached. To take silage from the trench the tractor is detached from the mixer distributor.
3. If the size of the herd exceeds 373 cows it is more useful to use a self-propelled type feed mix preparation and distribution aggregate with which it is possible to perform all animal feed mix preparation and distribution operations.

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