KAPITEL 8 / *CHAPTER 8* [8]

THE DESIGN FEATURES OF THE COMPOUND FEED DISPENSER FOR DAIRY ROBOTIC MILKING SYSTEMS BY GEA

DOI: 10.30890/2709-2313.2023-17-04-017

While conducting the experiment, the results of the authors' previous researches in the field of technology of animal products were used.

The development of dairy farming in the EU has contributed to introducing automated milking systems without any manual work (Lehkodukh & Lutsenko, 2018).

In Europe and the United States, technical and technological solutions for robotic milking are developed by Lely (the Netherlands), DeLaval (Sweden), Westfalia Landtechnic, GEA (Germany) and others. Milking robots are exported to many countries together with enclosed computer software algorithms that provide functional work and herd management (Piwczynski, Gondek & Sitkowska, 2020).

However, experience shows that new approaches and technological solutions that farmers receive together with imported equipment require adaptation to the conditions at livestock farms. First of all, this concerns design features of feed dispensers and opportunities to monitor work in order to make timely adjustments of feeding cows according to standards.

As proved in the monograph by G.O. Bogdanov (2012), for a high-yielding cow in physiological phases of milk yield and lactation peak, dry matter (DM) intake is the main factor in consumption. During the period, the need for dry matter of a cow weighing approximately 700 kg in terms of 4% fat milk should be 24-25 kg, and at the same time the rate of energy concentration has the peak for 10.7-11.5 MJ /1kg DM. Therefore, when feeding high-yielding cows, energy supply is also a key factor on which their milk productivity depends. When feeding the animals, other indicators and nutrient constants (40-45) are also taken into account, which have different effects on the quantity and quality of milk, health status and reproductive function. A balanced diet consists of combining feeds in the amount necessary for the animal to provide all nutrient indicators and ratios. It is impossible to achieve the required normalized amount for high-yielding cows - maximum energy levels with traditional coarse, juicy, concentrated feed. A cow with a daily milk yield of 30-35 kg should get 55% of energy from concentrate feed. The higher productivity, the higher energy concentration and ratio of concentrate feeds in the diet. The requirements for the concentrate feeds are changing as well. Targeted concentrate feeds with a normalized concentration of protein, fat, premix as a source of mineral and biologically active substances are being

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developed (Bogdanov, 2012).

A diet containing more than 50% concentrates has a high energy value, stimulates milk productivity, but it has a negative effect on health due to low fiber intake. A cow can be poisoned with feed carbohydrates leading to possible fatal outcomes (carbohydrate depression), or metabolism gets disturbed, milk quality decreases, cows suffer from many specific diseases: cachexia, ketosis, reproductive function, hoof and udder diseases, etc. The quality and quantity of concentrate feed has a significant impact on milk productivity and health (John, Garcia & Kerrisk, 2019). Therefore, when feeding high-yielding cows, the daily amount of feed is divided into many small servings to prevent problems when digesting nutrients. The main methods of serving feeding include: use feed mixture, feed while milking or individually at feed systems.

Dairy robotic milking systems by GEA include a feed dispenser, which is designed to give up to 15 servings per day. The number and weight of servings depend on many factors. It feeds each cow individually at request. The algorithm is aimed at feeding the maximum amount of feed without harmful risks of overfeeding (Gea Farm Technologies – Agricultural machinery). The design features of the system allow to calculate a larger number of servings and weight of feed, if the risks are scientifically justified. An equally important problem was solved – feeding was synchronized with milking, thus ensuring animal welfare in the dairy robot.

Due to feed dispensers, dairy farming in the leading countries of the world has already given up keeping, feeding and milking cows on pastures (Hofstetter, Frey & Gazzarin, 2014). Improving the operation of the feed dispenser of the dairy robot requires increasing levels and economic indicators of milk yield. Land resources and energy are rationally used. The system of feeding, keeping and milking cows is being improved.

The purpose of our research is to define the design features of the feed dispenser at the GEA Monobox robotic milking system, taking into account its functional properties in an automated mode - to provide cows with feed depending on the level of their productivity, age, fatness, etc.

Literature review

The paper presents the results of normalized feeding of dairy robots because manufacturers do not provide complete information. This also applies to the feed dispenser of GEA Monobox (the flyer of GEA Ukraine, 2018).

For over 10 years, dairy robots have been in use worldwide. They are already considered traditional abroad (Gargiulo, Lyons, & Kempton, 2020). In Ukraine, only the best agricultural companies have been using dairy robots. Well-known scientists, A. Naumenko (2014), A. Paliy & A. Paliy (2019), A. Chyhryn (2015) report on

technical and technological innovations in domestic dairy farming, the features of dairy robots and their advantages.

V.I. Lebedinsky, I.V. Hnoievyi & T.A. Buhai (2019), claim that effective use of dairy robots depends on a high scientific and technical level of economic activity of milking farms: scientifically explained feeds, modern technologies of production, storage and use of feed, loose housing of cows in comfort, year-round one-type feeding with biologically complete feed mixtures, high-quality reproduction of the herd. According to A.V. Maklakhov (2017) economic studies on operating costs have shown the benefits of robotic milking: the profitability of milking farms increases by 22% compared to tethered cows, 8% more than traditional milking cows in the hall.

Highly productive dairy cows need to be additionally given concentrated feed. (Shimizu Y., Cundall P.A., 2001). But such feeds can be toxic to cows if they are fed without restrictions.

An automated feeding system, which is based on an automatic dispenser, is of great importance in feeding high-yielding cows. At a scientifically justified level of consumption of combined feeds, the risk of cow disease is minimal. This is one of the ways to increase milk productivity. Since the volume of concentrates for every cow is individual, it must be calculated according to the appropriate method taking into account the daily milk yield (Lyalin E.A., Trutnev M.A., 2018).

The principle of operation of the compound feed dispenser can be understood using information from related milking technologies. First of all, the principle of operating feed systems, which are installed on farms for individual feeding of separate servings per day. Automatic animal identification must be introduced with a radio device – a sensor attached to the cow's ear or on a special collar (Bloch & Pastell, 2020). It is important to be able to adjust the performance of the compound feed dispenser yourself, since the time required for mixing and dispensing loose, granular and other feeds varies.

Compound feed prepared directly on the farm is 1.5-2 times cheaper. Therefore, their own production became a condition for increasing profitability (Yatsenko Yu.V., PiskunV.I., 2019, Banha V., Krupych O., 2019).

In the world, there are two ways of dosing feed – volume and weight. Dispensers can operate in continuous and portion modes. Weight dispensers have high accuracy with a margin of error – 0.1 to 1.0%, but they have a drawback – equipment complexity (Kondratov, Ozhigov, & Mefod`ev, 2008). They need highly qualified maintenance specialists, they have low productivity and high inertia. All this hinders their popularity at milking farms.

Materials and methods

The research was carried out at the Private Agricultural Enterprise "Vilshanske", Dvurichansk district, Kharkiv region in 2019, where two GEA Monobox robotic milking systems (Germany) had been in use since 2019. The feed dispensers of the robotic milking systems were set for 100-120 g of feed to cows per 1 kg of milk. The cows of the Ukrainian black-and-white dairy breed were of exemplary welfare (kept loosely) for year-round feeding with compound feeds according to detailed norms with free access to feed and water. All the necessary information about the weight and number of servings, productivity, etc. of each cow individually was sent to the milking work computer, and was then used to carry out experiments.

Zootechnical research was conducted as scientific and agricultural experiments. They studied the influence of the chemical composition of feed, compiled a program of recipes for combined feed depending on cows, age, fatness, lactation phase of cows, level of their productivity, etc. These materials were entered into the dairy robot program for individual calculation for each cow. Conducted food intake analysis. They studied the level of milk productivity depending on the total amount of combined feed consumed per day and one milking, the number of its portions. The duration of milking was studied depending on the simultaneous consumption of feed. The key point of these studies was the organization of the process in such a way that the cow had time to eat the entire amount of the offered feed during milking. The work of the dairy worker is programmed to milk the cow depending on the level of productivity, without restrictions on the number of milkings per day. Therefore, combined feed was issued depending on the number of approaches of the cow to dairy work. Regulation of the operation of the dispensers in the conditions of intended use was carried out in accordance with the technical and technological methods of research.

Research results

It was found that the technology of feeding cows with robotic milking is significantly different from feeding in the milking parlor. As a result, the role and importance of feed dispensers has changed. In milking systems, they are the main technical and technological means that provide standardized feeding due to cow's level of productivity, age, fatness, etc. Naturally, all these technological functions of feed dispensers perform due to their design features.

Individual feeding of compound feed according to the technology of industrial milk production takes place when one is aware of the dosing control process.

The amount of concentrate feeds in the main feed mixture for cows using a dairy robot may exceed or be in deficit compared to the actual need of the feed. In order to timely influence the quantity and mode of consumption, specialists of the milking

farms must be well aware of both design and functional features of feed dispensers.

Studied the design features of compound feed dispensers from different companies. It was established that depending on the level of automating dosing process, dispensers can be manual, semi-automatic or automatic. Manual dosing process is controlled by an operator. For semi-automatic dosing, an operator uses serving counters, units to supply feed into the dispenser and other auxiliary mechanisms. Automatic dispensers measure a certain amount of feed, regardless of changes in parameters, or in a closed cycle, when the change in feed dispensing takes place in accordance with the command of the regulating units.

Figure 1 shows the principle of operating a feed dispenser in the GEA dairy robot (the flyer of GEA Ukraine, 2020). A cow receives a portion of combined feed, taking into account the following factors: productivity level, lactation phase, age, fatness, health status. The receiver of the automated system of the dairy robot receives a signal from a transponder located on the cow's neck. The micro computer of the dairy worker calculates indicators: the amount of compound feed per 1 kg of milk, the amount of compound feed per 1 cow, the number of portions of compound feed, the dispenser adjusts the feed and supplies it to the feeder for consumption.

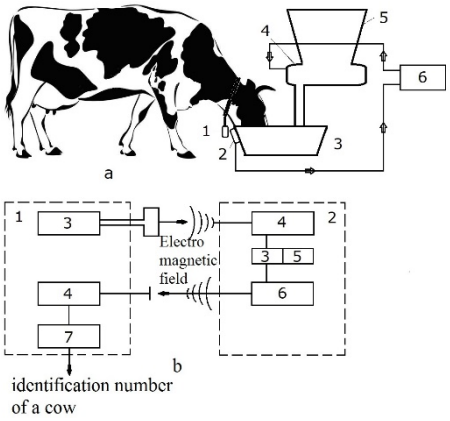

Figure 1 - Automated system of individual feeding of cows:
a – technical scheme of the system: 1 – transponder, 2 – transceiver, 3 – feeder, 4 – dispenser, 5 – hopper, 6 – microcomputer; b – functional scheme of the system: 1 – identification unit, 2 – transponder, 3 – generator of electromagnetic waves, 4 – receiving unit, 5 – memory unit, 6 – transmitting unit, 7 – decoding unit
Source: *(figure of V. Shigimaga, Research Tatiana Buhay)*

An important component of such a sensor is a transponder, which combines the receiving and transmitting units. The transponder circuit is powered via ferrite rod antennas for reception from a generator that is part of the identification unit.

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Volume dispensers are simpler in design, cheaper, have a flow dosing process, and quality indicators allow all types of feed manufacturing and dispensing.

The design of dispensers depends on feed types: drum, plate, belt and screw dispensers are used for dosing dry feed (Fig. 2, a-d) (Kondratov, Ozhigov, & Mefod`ev, 2008).

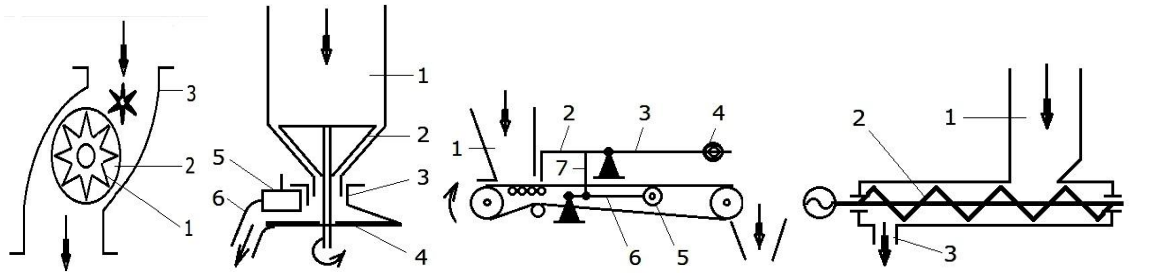

Figure 2 - The design features of compound feed dispensers: *a – the scheme of a drum compound feed dispenser: 1 – wheel, 2 – disc, 3 – dispensing stimulator; b – the scheme of a plate compound feed dispenser: 1 – hopper, 2 – agitator, 3 – mobile transmitter, 4 – rotating disc, 5 – scraper, 6 – dispensing tray; c – the scheme of a belt compound feed dispenser: 1 – accepting bucket, 2 – regulating unit, 3 – balance beam, 4 – freight, 5 – roller, 6 – lever, 7 – haul; d – the scheme of a screw dispenser: 1 – hopper, 2 – screw, 3 – discharge hole.*

Source: *(figure of V. Shigimaga)*

A drum dispenser has a cell drum as a working body, which consists of several wheels "1" (Fig. 2, a), separated by disks "2". The shape of the cross section of the wheels depends on the physical and mechanical properties of the feed. The dispensing stimulator "3" provides even drum-based feed distribution. The volume of product is directly proportional to the speed of the drum.

The plate dispenser (Fig. 2, b) has a different scheme: the feed is in the accepting hopper "1", in the conical part of which agitator "2" rotates. At the bottom of the hopper, there is the mobile transmitter "3", the location of which determines the intensity of the feed on the rotating disk "4". The scraper "5" gets the feed into the appropriate tray "6". The performance of the dispenser is adjusted by shifting the

mobile transmitter "3" and the scraper "5" or by changing the rotating speed of the disk.

The belt dispenser is intended for uninterrupted dosing either by volume or weight. The feed gets into the hopper "1" (Fig. 2, c), from which it falls on the transponder tape with a layer, the thickness of which is set automatically by means of a gate mounted on the rocker arm of the balance beam "3" with the freight "4". The transponder tape rests on the roller "5". As the load on the belt increases, the roller "5" is lowered and through the system of levers "6" the haul "7" influences the balance beam "3", reducing the thickness of the feed layer on the dispenser belt. Possible ways to regulate productivity include moving the freight "4" on the balance beam "3" or changing the belt speed.

The screw dispenser is based on the principle of volume serving (Fig. 2, d). The feed gets into the hopper "1" and is moved by the screw "2" to the discharge hole "3". The performance of the screw dispenser is regulated by changing the frequency of the dispenser holes.

In the brochure of the GEA milking system, there is a scheme of the compound feed dispenser (Fig. 3) as well as some functional features of dispensers (GEA Monobox…, 2020).

Figure 3 - The scheme of the compound feed dispenser by GEA

Source: *(The flyer of GEA Ukraine…, 2020)*

The GEA brochures state the following (the flyer of GEA Ukraine…, 2020):

The amount of feed per day is calculated with the computer software Dairy Plan for herd management, which also determines a required amount of feed individually. The methods of feeding animals can be adjusted in different ways. Some animals can be fed automatically, while for others the software should be set individually.

Introducing an individual amount of compound feed. To "manually" give feed to animals, an operator must click on Individual feeding in the computer menu. A corresponding window opens, with the fields to enter the required amount of feed. The entered data is saved automatically.

Automatic calculation of the total amount of feed. You can automatically calculate the total feed requirements based on the state (duration) of lactation, productivity and weight of the cow, etc., based on the data entered into Dairy Plan.

Feed dispensers by GEA can automatically maintain the upper and lower limits of the daily feed norm and divide it into a given number of servings over a certain period of time.

The following tasks are solved:

1. Increase productivity and quality of dairy products.

2. Improved the principle of operation of the dispenser.

3. Decided on the possibility of dividing the daily rate of compound feed into required amount portions depending on the level of productivity of the cows and their physiological state.

4. Due to the increase in the number of portions of compound feed, the duration of the consumption of compound feed by cows in milking work was increased to the level of time spent on milking them.

The last task is extremely important from the point of view of ensuring the welfare of the cows during their milking.

After observing the operation of the dispenser and consultations with the maintenance staff from the supplying company, the conclusion is that the milking system has a technical device based on the principle of volumetric dosing of dry feed. Dividing the feed rate into a significant number of individual servings can be explained by the desire of its designers to comply with certain requirements regarding the dimensions of this technical unit and energy saving. It should be agreed that the authors achieved the goal. The small-scale hopper of the dispenser has a rotor, which is driven by a pneumatic pump connected to an electric motor with a capacity of 40 watts. One turn of the rotor is one feed serving, which can be 0.120.19 kg or 0.180.28 l (1 liter of feed = 670 g), depending on the weight of feed consumed and the number of servings (Table 1). Moreover, it can be assumed that the design features of the dispenser make it possible to increase or decrease the feed yield per 1 serving. The duration of serving can be also increased or decreased by changing the mode of operation of the rotor. The last variant of operating the dispenser is very important in the aspect of synchronizing the duration of feed delivery and its consumption by cows on the milking system.

In the experiment, which the authors conducted at the Private Agricultural Enterprise "Vilshanske" the amount and the structure of compound feed in the main feed mixture was increased. It was found that economically useful indicators of the dairy herd significantly depend on the compound feed from a dispenser (Table 1).

Table 1 - Compound feed consumption and productivity of cows per milking

Indicators	Research periods		± II до I, %
	I	II	
Milk yield per cow, kg	11.4±0.59	17.4±1.70	+52.6
Compound feed consumption, kg	2.8±0.24	2.1±0.13	– 25.0
Compound feed servings, pcs	15.1±1.4	18.0±1.5	+19.2
Compound feed per 1 serving, kg	0.19±0.03	0.12±0.03	– 36.9
Compound feed per 1 kg of milk, kg	0.25±0.03	0.14±0.03	– 44

Source: *Author's Tatiana Buhay & Ihor Hnoievyi*

The upper limit of compound feed consumption was determined and observed at 5.00 kg / day. The norms of compound feed consumption for lactation were determined due to the level of milk productivity by months, its percentage in the main mixture was increased. This made it possible to increase the amount of feed consumption by 3.75 kg per cow on average in the herd.

Under the new conditions of feeding cows, the amount of compound feed consumed per one milking decreased from 2.8 kg to 2.1 kg or by 25.0%, while the number of servings increased from 15.1 up to 18.0 or 19.2%. At the same time, the weight of compound feed per 1 serving decreased by 36.9%. Compound feed costs per 1 kg of milk decreased by 0.11 kg or 44%.

Figure 4 shows a graph of the experimental ratio of milk yield per milking (in liters) to feed servings (intermittent curve with dots).

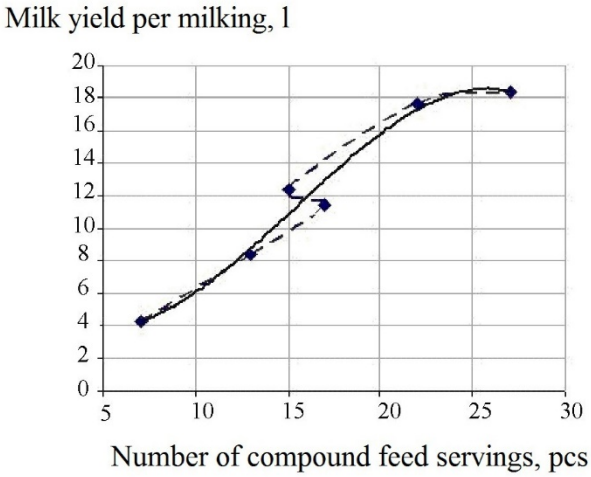

Figure 4 - Ratio of milk yield per milking (in liters) to feed servings.

Source: *Research Tatiana Buhay, Ihor Hnoievyi, figure of V. Shigimaga, text Mykola Bezuhlyi, Alexander Naumenko*

The obtained experimental ratio is approximated by a third-order polynomial (black solid curve):

$$y = 0{,}032\,x - 3 + 0{,}194\,x - 2 - 1{,}2389\,x + 6{,}7645,$$

where y – milk yield per milking, x – number of compound feed servings. The coefficient of determining the experiment – polynomial: R^2=0,97.

Figure 4 shows that milk yield increased together with feed servings, reaching maximum speed when the number of servings reached approximately 15. However, then the rate of milk yield slowed down and was almost zero when the number of servings exceeded 23. Hence the conclusion is that increasing the number of servings over 15 is impractical, because milk yields did not increase, so energy costs were not justified.

Experimental ratio of milk yield to the amount of fed compound feed per milking has no justification (Fig. 5). This is due to the fact that the milking system automatically monitors several parameters of the cow, including its productivity, milk quality, live weight, etc. If a young cow grows or it is thin, the system gives it more feed, not taking into account its milk productivity, ie the system performs multifactor control of the cow.

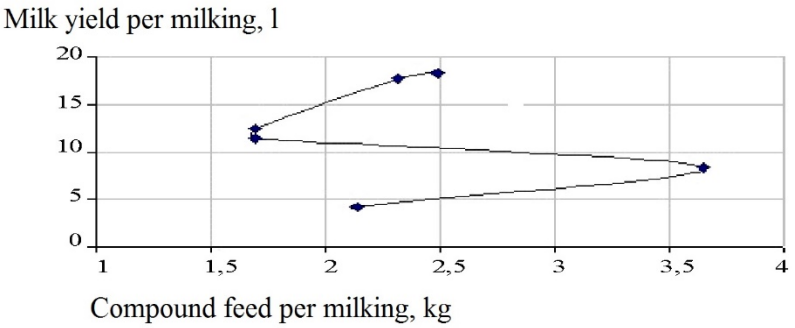

Figure 5 - Ratio of milk yield weight to fed compound feed (in liters) per milking
Source: *Research Tatiana Buhay, Ihor Hnoievyi, figure of V. Shigimaga*

The experimental ratio of milking duration to milk yield is a wavy function that has no clear period (Fig. 6).

The dependence is caused by physiological features of cows (milking speed) or a stressful condition, etc. However, the range of fluctuations while milking does not exceed 50 seconds, which may also mean the influence of technological features of milking cows by the robot.

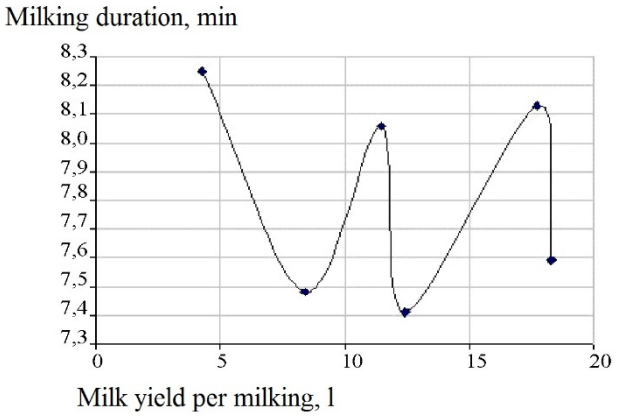

Figure 6 - Ratio of milking duration to milk yield

Source: *Research Tatiana Buhay, Ihor Hnoievyi, figure of V. Shigimaga.*

No significant relationship between the duration of consuming 1 serving (frequency of eating) and the number of servings, because they depend on the amount of feed consumed by cows, ways of using servings, etc.

Scientific data indicate great design capabilities of the feed dispenser by GEA. It should be added that it works in extreme production conditions around the clock for several years, which indicates its high technical reliability. However, the robot dispenser requires constant monitoring in order to timely adjust the use mode. After using milking robots at the Private Agricultural Enterprise "Vilshanske" for two years in the technological mode, experts noticed that the cows gradually began to consume less of the main feed mixture. There was also a decrease in milk fat, which is a sign of acidosis due to overfeeding with concentrated feed. There was no upper limit on the amount of consumed feed. Due to age, fatness and other factors, cows could get 6 or more kilograms of feed per day. Its amount, which was in the main feed mixture and was fed from the feed table, was not taken into account.

Therefore, the upper limit of feed consumption in the milking system was determined as 5 kg and no more than 27 servings. The new mode of operating the feed dispenser had positive results:

– the degree of consuming the feed mixture from the feed table increased from 85% to 100%;

– milk yields per 1 milking increased, on average, from 11.4 ± 0.50 kg to 14.7 ± 1.7 kg in the experiment;

– milk fat content increased from 3.43 ± 0.01% to 3.49 ± 0.07%;

– protein content increased from 3.20 ± 0.01% to 3.26 ± 0.01%.

The research data face great prospects, as only milking systems solve the issue of individual feeding of high yielding dairy cows. The condition of each quarter of the

udder is also examined, signs of mastitis and other diseases are detected in due time, etc. The effectiveness of using milking systems is also about creating comfort for cows.

Discussion

There have recently been positive experiences of using the GEA Monobox robotic milking system (Germany) of automated milking at Private Agricultural Enterprise "Vilshanske", Dvurichansky district, Kharkiv region (Lebedynskyi, Buhai & Hnoievyi, 2019).

As evidenced by our results, the use of compound feed dispensers allowed to increase the quantity and quality of milk. Mogilevsky (2013) and Sitkovska (2020) note that the lack of contact of milk with the external environment also significantly increases its quality.

The automated milking system monitors the level of productivity, milk quality, behavior and health of the animal, at the same time allowing to conduct research at the enzyme level, including analysis of lactate dehydrogenase (Antanaitis, Malasauskiene & Televicius, 2020).

Many factors of keeping cows in welfare, according to the peculiarities of their influence on cows, have acquired specific significance, so they have become an important component of managing dairy farming (Hnoievyi et al., 2018).

In such an automated system, the necessary milking functions are performed. There is also an active feed dispenser. With skillful use, it provides normalized feeding of cows, so it has a positive effect on their milk productivity, as proved by the research results.

The obtained results are explained by the fact that the use of a significant amount of feed did not lead to adverse effects. This is reflected in Table 1, which clearly shows that the bigger servings, the more milk. The research results are a continuation of the authors' work, which proves that within 3 years and 10 months milking systems can be compensated on condition of high milk yields (Chigrin & Palij, 2015).

The peculiarities of the suggested method and the obtained results are explained by the fact that it is possible to automatically adjust the distribution speed and feed time of the dispenser in the milking systems. Thus, the number and size of servings for feeding high yielding dairy cows can be individually adjusted. This reduces the risk of acidosis as proved with the authors' research results and other works (Lebedynskyi, Hnoievyi, & Buhai, 2018; Song, van der Tool & Koerkamp, 2019).

Analyzing the research results, the conclusion can be made that the more feed cows consume, the higher milk productivity they have. The amount of concentrate consumed by a cow per day has a significant impact on milk production. However, there is a physiologically justified upper limit of consumption – at the level of 65% in

the diet. Exceeding this amount can lead to numerous diseases or death from poisoning. Therefore, when organizing the feeding of highly productive cows, the requirements of distributing the daily norm of concentrates on many servings are met. Automatic feeders are used as they provide each cow with feed according to software algorithms. This approach helps to stabilize the level of enzymatic processes while digesting nutrients.

We consider it very important that in our studies, during milking and being in dairy work, the cow consumed the entire offered portion of the combined feed, and her productivity and milk quality increased. The rest of such feed, together with its own portion, would be eaten by the next cow, which could lead to overfeeding with negative consequences (Borshchenko V.V., Kucher D.M.. 2021). Researchers point to the depression of milk fat in such situations (Mansbridge R.J., Blake J.S., 1997, Jenkins T.C., 1998). In the article of Mentin R.L., Cook N.B (2006) it is proved that the abnormal consumption of feed by a cow necessarily negatively affects the qualitative composition of milk. Overcrowding of the feedstalls with a combined mixture, placement of heifers with older cows in farms, feeding concentrates before the main feed, all such methods of feeding management have a negative effect on the yield and quality of cow's milk (Tyasi T. L., Gxasheka M., Tlabela C. P (2015). The higher the level of productivity of cows, the more professional the job of regulating their feeding is.

One of the disadvantages of the method may be economic factors. By setting a new mode of operating the feed dispenser and using more feed, the expected economic effects may still not be achieved. Therefore, this method is recommended only for cows after calving and at peak milk levels, i.e. when they are able to increase the level of milk productivity and keep it high for a long time. Cows that have already passed the level of maximum productivity should switch to automatic dosing of feed intake depending on the above factors.

The problem of adapting different genotypes of cows to milking systems is also important (Borshch, Gutyj & Sobolev, 2020).

The problem of adapting different genotypes of cows to milking systems is also important (Antanaitis R., Malasauskiene D., 2020, Antanaitis R., Juozaitiene V., 2020). As stated in the article by V. Legkoduh & M. Lutsenko (2018), as well as in a number of DeLaval robots: (Instruction Book, 2008, Heike Diez, 2014, Tina Müller, 2020), there are shortcomings in the operation of automated milking systems. This is unsuitability for robotic milking due to various reasons of a significant number of cows (up to 15%), a small number of robotic farm projects in Ukraine, low qualification of personnel in managing the robotic milking system, etc. In our work, we also

encountered the problem of adjusting the compound feed dispenser for its consumption by high-yielding cows in accordance with the detailed norms of their feeding. Since the time the cow spent in milking work was too short to consume the entire portion of such feed. We have successfully solved this problem.

Conclusions

1. The milk yield of cows increased with the simultaneous improvement of its quality due to the increase in the number of portions of combined feed at the same time as the reduction of its consumption during the stay of the cow in dairy robot in the process of one milking. Taking into account the productivity of cows - more than 12,000 kg of high-quality milk, let's pay attention to increasing the share of "bypass" starch and protein in combined feed.

2. Improvement of the principle of operation of the feed dispenser of the dairy robot made it possible to increase the degree of consumption of the feed mixture by cows to 100. There is a prospect of further improvement of its work in relation to loose and granular fodder mixtures.

3. The daily rate of combined feed was divided for each cow into the required number of portions in accordance with detailed feeding rates, the level of productivity of cows, the lactation phase, fatness, the duration of the consumption of combined feed by cows in milking robot was coordinated with the level of time spent on milking them. Control over the consumption of dry matter of combined feed, reduction of laminitis statistics is one of the areas of further research.

4. Feeding mixed fodder according to portions has correlative connections with milk yield. Increasing the number of its portions does not always increase milk productivity. Cows react individually to new feeding conditions. The problem of insufficient space near the compound feed dispenser in milking robot can become a stress factor for individual cows.

Acknowledgements

The authors of the article would like to express their very great appreciation to thank the management of the Private Agricultural Enterprise "Vilshanske", Dvurichansk district, Kharkiv region, particularly to Viktor Ivanovich Lebedinsky and the staff of the dairy farm, where more than 500 cows are kept in exemplary welfare. Modern technological, highly organized research allowed to milk over 12,000 kg of high quality milk in 2019 with production profitability of more than 40%.

Conflict of interest

The work described has not been previously published, is not under consideration for publication elsewhere, its publication has been approved by all authors AND the responsible authorities where the work was performed. If accepted, it will not be published elsewhere in the same form, in English or any other language, including in electronic form, without the written consent of the copyright owner.