INTRODUCTION OF DIGITAL TECHNOLOGIES IN DAIRY CATTLE BREEDING OF THE REPUBLIC OF KAZAKHSTAN

Luidmila Alimzhanova[1], Issabekova Saltanat[2]

Abstract: the article presents the results of the introduction of digital technologies in dairy cattle breeding in Kazakhstan. The object of the study were cows in which boluses were introduced with the measurement of activity, temperature and the level of rumen acidity. Using boluses, the management of personnel, watering and feeding was improved, due to which the milk productivity of cows has been increased. Detection of heats due to boluses has been increased up to 90%. The average positive correlation between rumen acidity and milk productivity level has been established, with a decrease in rumen acidity, the milk productivity level of cows decreases. Seminars were held to disseminate knowledge on the introduction of digital technologies in the dairy cattle breeding.
Keywords – automation, informatization, digitalization of dairy farming, bolus, rumen pH, milk productivity, feeding, feeding behavior.

1. INTRODUCTION

Automation of systems for health maintaining and managing is becoming increasingly important in animal science. Existing diagnostic methods and tools for early detection of impaired reproductive function and overall animal health are not widely used, in many cases the use of such tools is too expensive or difficult to install at the farm level. With the help of technical innovations, direct and indirect health parameters, such as body weight, body temperature, cow mobility, can be easily determined, and long-term measurement of the pH of the rumen allows us to establish the correct feeding or feeding behavior [1]. There are a number of studies [2] indicating that behavioral changes can be attributed to poor health. Feeding behavior was recognized by several authors [3,4] as a suitable indicator for obtaining information about the health status of cows due to direct and indirect participation in physiological processes.

In this regard, the focus is on new knowledge and trends in welfare biomarkers (stress and metabolic diseases), welfare assessment based on activity (estrus and lameness detection), temperature and pH sensors (calving prevention function and rumen function) and their combination, integration into "Smart" systems that ensure optimal well-being for dairy animals and thereby maximize farm profitability [5-10].

The development of computer technology, the Internet and mobile applications have opened up new possibilities for the use of computers and equipment using certain sensors that respond to specified parameters of the study of the animal.

2. PROPOSED ALGORITHM

Scientific research under the program "TRANSFER AND ADAPTATION OF INNOVATIVE TECHNOLOGIES FOR OPTIMIZING THE PRODUCTION PROCESSES IN DAIRY FARMS OF NORTHERN KAZAKHSTAN" is carried out on the basis of model farms in LLP "Family Farm", LP "Mambetov and Company" and LLP "Olzha-Sadchikovsky", which are located in the northern region of Kazakhstan with a sharply continental climate. **North Kazakhstan region** includes steppe land, wooded in the northwest and the picturesque, hilly lake district in the south. The climate of **North Kazakhstan region** is of sharp continental. Winters are frosty and long (over 5 months), with little snow, summers are hot, mostly clear and often droughty weather. The economics of **North Kazakhstan region** is predominantly agricultural: crops, mainly food grains, are grown on the fertile soils, and sheep breeding and dairy farming are important. The territory of Central Kazakhstan covers 398.8 thousand sq. km. Its population 1.72 million people, with a population density of 4.5 people per sq. km., 86% of whom live in towns and settlements.

Milking cows were selected at these model farms, 200 animals in each farm, to whom boluses were installed, and of this number, according to the technology of the bolus system developers, 10% boluses with pH measurement of the rumen were installed as well.

In the field of animal science, research was carried out by generally accepted methods of scientific research in animal science, statistics were processed by RStudio software.

The purpose of the research was to study the impact of the digital technologies introduction in dairy cattle breeding in the Northern region of Kazakhstan.

The objectives of the study included following:
- to study the effects of feeding time on the rumen health of dairy cows;
- to establish the relationship between the pH of the rumen and milk productivity.

[1,2] S.Seifullin University, Nur-Sultan, Republic of Kazakhstan

- to control cows' reproductive function;
The implemented bolus system consists of:
- boluses of various modifications - basic bolus and boluses with pH measurement;
- base station and repeater;
- climate sensor;
- control system.
Key features:
- definition of heats;
- health monitoring;
- monitoring of feeding and water consumption by animals;
- prediction of calving;
- determination of heat stress (indoor microclimate).
All animals before the introduction of boluses were subjected to clinical research, that is, health status was established.

3. EXPERIMENT AND RESULT

Many studies have shown that the presence of a disease reduces the productivity of dairy cows, it is also clear that with an increase in productivity, susceptibility to diseases such as metabolic disorders and reproduction increases [11-16].

The diagrams that can be obtained from the bolus system except the acidity level (green curve) also show temperature data (blue curve) and animal activity data (red curve). The obtained activity and body temperature data allow us to make decisions on reproduction issues, as well as veterinary issues and analysis of the animal's drinking cycles (Figure 1).

Figure 1 – Dynamics of pH level, temperature and animal activity

Feeding of cows in LLP "Olzha-Sadchikovskoe" is carried out 2 times a day-in the morning and in the evening, concentrated feed is additionally fed at lunchtime. Distribution of forages is carried out on a fodder table. Feeding time has a very big impact on productivity.

From figure 1 it is seen that the cow is fed daily at different times, the optimal time for feeding this herd for days without warning about the efficiency of feeding is 8.00 hours, this allowed to judge and make further recommendations, to start the distribution of feed at 8.00 a.m., which increased feed efficiency in the economy and in future bring the pH to normal in most cows with pH bolus.

According to the purpose of our project, the studies were aimed at establishing the relationship between the pH level of the rumen and the milk production of cows. In the basic farms, feed samples were selected to determine their chemical composition and study the nutritional value. When organoleptic evaluation of feed, all feed was of good quality, all the feed harvested in the farm are close to the standards for nutrients.

The cows were analyzed milk production and the analysis of quantitative and qualitative indicators. So the milk yield of Holstein-Friesian cows was at the level of 16.9 ± 2.41 kg, the percentage of fat 3.9 ± 0.02% and protein 3.4 ± 0.05%. In general, we can say that, all other indicators such as NFMS and density were within the normal range for the Holstein-Friesian breed. Also, the health indicator of the udder (somatic cells) was within normal limits, which amounted to 187.3 ± 5.95 thousand / ml.

The effects of acidity on the milk production of cows can be seen in the example of one cow in which a bolus with a pH measurement is placed. Data was taken from cow №USA72099496 for 71 days of lactation, during the month there are jumps in rumen acidity by an average of 0.70, as can be seen in Figure 2.
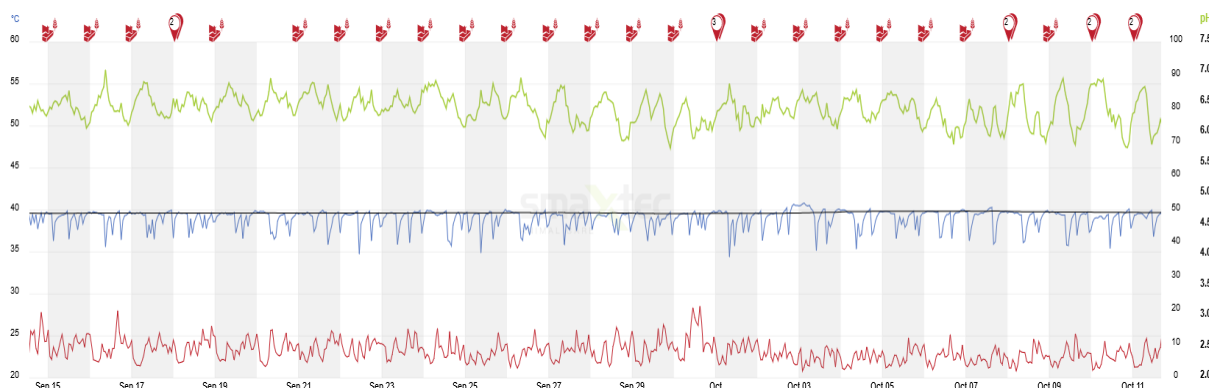
Figure 2 – The level of acidity of the rumen in a cow №USA72099496.

According to the author of the bolus J.Gasteiner, the increase or decrease in acidity during the day is not so terrible. It is more important not to allow sharp jumps in acidity for several days at the same time, the permissible rate of change in pH is 0.40-0.60.

As can be seen from the figure in the declared period, the system daily for a month informed about reduced feeding efficiency. When analyzing milk productivity in the same cow, we observe the following dynamics, on the 71st day of lactation it shows a sufficient level of average daily productivity for this breed - 25.7 kg. And already on the 101st day, that is, the 3rd month of lactation, there is a sharp decrease in more than 10 kg of milk, which amounted to 15.4 kg. The quantitative composition of milk in the 2nd month of lactation was within the normal range for the breed: fat - 3.7%, protein - 3.5%. By the 101st day of lactation, the amount of fat is lower compared to protein: fat - 3.38%, protein - 4.73%. When determining the number of somatic cells in the 2nd month of lactation, this indicator was within the physiological norm - 268 thousand / ml; during the next control milking, the number of somatic cells was very high - 970 thousand / ml, which indicates inflammatory processes in the udder in this period, which is most likely associated with a general decrease in immunity due to improper feeding.

The same results were obtained when establishing the relationship between the pH of the rumen and milk production in LLP "Family Farm", only there jumps in acidity and the number of somatic cells change during the day.

LLP "Family farm" monthly carries out control milking, which showed that milk production was at the level of 18.3 ± 2.51 kg, fat percentage 3.72 ± 0.05% and protein 3.22 ± 0.03%, the amount of somatic sells 213.7 ± 7.32 thousand / ml.

However, notifications about incorrect feeding of cows also come in this farm (Figure 3).
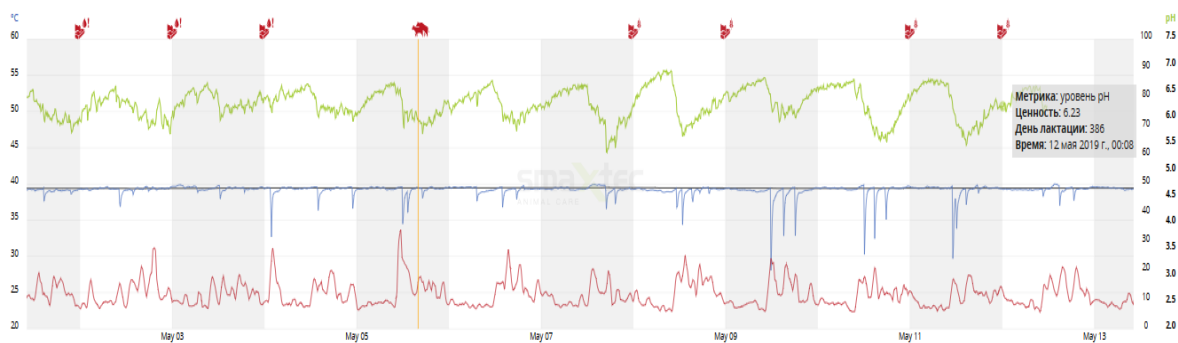

Figure 3 – Cow rumen acidity level in LLP "Family farm"

Daily jumps in rumen acidity leads to various diseases ranging from ketosis to laminitis. So, during the control milking in the month of September, we observed the number of somatic cells within 136 thousand / ml in a cow in milk in the morning milking, which is an indicator of the healthy udder rate, whereas in the evening this indicator was equal to 566 thousand / ml, which means the beginning ofmastitis.

During biometric processing of milk productivity and acidity, it showed that the average daily milk yield of cows at LLP "Olzha-Sadchikovskoye" for October amounted to 16.9 ± 2.41 kg, while for cows with reduced acidity 13.4 ± 1.62 kg. When calculating the correlation coefficient between the pH level and average daily milk yield of cows, an average positive relationship of +0.33 was determined, which suggests that with a decrease in acidity in the rumen, the milk productivity of cows decreases. From this we can conclude that a high level of rumen acidity negatively affects milk productivity.

The following research results were obtained in the LP "Mambetov and Company". During the control milking in August, animals with a hung content of fat and somatic cells in milk were revealed, which indicates a violation of the digestive processes and the presence of inflammatory processes of the udder.

The amount of fat in these animals was 6.24% and the number of somatic cells was 1376 thousand / ml. These changes in milk also converge with the data obtained from boluses, which are shown in the following figure (Figure 4).
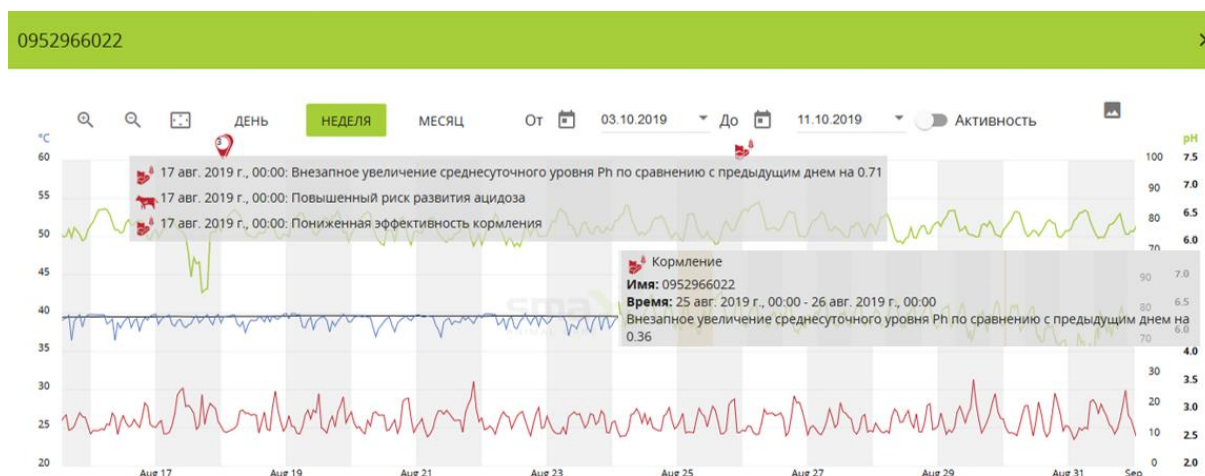

Figure 4 – Change in the acidity of a cow №095296622 in LP "Mambetov and Company"

As can be seen in the figure, fluctuations in the acidity of the rumen were observed in the days before the control milking and after, which ultimately affects the composition of milk, as well as milk yield. A few days before the control milking, there was a message about a decrease in the feeding efficiency of this cow, and since a bolus with a pH measurement was placed on only 10% of the cows, other cows of the milking herd experienced the same problems, as evidenced by the average amount of fat in the herd - 5.09%, and the average daily milk yield was 12.3 kg. Work was done to adjust the feeding and control the fatness according to the BCS system, in animals there was a clear overfeeding. It was necessary to reduce the average feed and reduce the fatness of milking cows to an indicator of 3.5-3.75 points.

During the control milking in the month of September, not a single cow was found with an increase in the quantitative composition of milk, the average daily milk yield of the cows was 19.91 kg, which is 7 kg more than in the previous month, fat 4.00%, protein 3, 22% and the number of somatic cells 159 thousand / ml, these indicators are within the normal range for Simmental breed.

Reproduction of cattle is one of the main factors regulating the level of livestock products production. The increase in livestock on the farm is determined by the fertility of cows and the terms of their use. An integrated approach to solving this issue allows you to take into account factors affecting the reproductive function, and maintain at an optimal level [17-19].

The results of determining the immobility reflex by the method of two-time observation of the manifestation of the stage of sexual arousal in animals in comparison with messages from the bolus system system about the manifestation of sexual heatin cows are shown in Table 1.

Table 1 – Results of determination of sexual heatin cows by observation method and the bolus system

Determination method	n	Features	The definition of sexual heat,%
2-time observation method	30	arousal, estrus, sexual heat	56,6
The bolus system	30	activity, sexual heat	83,3

The results show that the bolus system with well-managed herd management can improve the detection of cows with signs of sexual heat by 26.7%, thereby increasing the fertility and percentage of pregnant cows. The change in temperature is also used as a parameter determining the onset of calving in the cow. To more accurately obtain data on the onset of calving in a cow, data on inseminated cows tested for pregnancy should be filled. The bolus system, after being diagnosed with pregnancy, indicates a preliminary date for calving. Lowering the temperature 1 day before the onset of calving, the system signals the calving time. The research results are shown in table 2.

Table 2 – The results of the determination of calving time by bolus system

Days before calving	n	Period of pregnancy	T	The bolus system	
				n	%
1-2	16	281±4,3	38,1±0,4	13	81,3
3-4	15	279±5,1	39,2±0,3	5	33,3

As can be seen in table 8, with proper accounting of inseminated, pregnancy-tested cows, the reliability of SmaXtec information about the onset of calving is confirmed in 81.3 % of cases. The use of this system allowed to increase the number of identified animals with sexual hunting by 26.7%, to determine the calving time in 81.3% of cows.

Seminars were held to disseminate knowledge on the introduction of digital technologies in the dairy cattle breeding. Over the two years of the project, 4 workshops were held. Information on the results of the use of boluses was listened to by more than 40 farmers who expressed interest in the new technology. Not all farms will accept a new idea at the same time. In any rural community, the readiness to accept new ideas and put them into practice varies from farmer to farmer depending on each farm's previous experience with new ideas. Thus we identified that small and medium need technological solutions to start a new or further improvement of their agricultural business and need to be trained further while larger farmers are interested in transfer and adaptation of foreign technologies and expansion of production.

4. CONCLUSION

Studying the characteristics of digestion in ruminants showed that the composition of diet has a significant impact on the formation of feed fermentation products in the rumen, and, consequently, on the degree of their use in metabolic processes, on body deposits and for milk synthesis [20-22].

Studies of I. Šematoviča [23] on the relationship between rumen pH and temperature with the milk composition showed that none of the above indicators affect the milk composition. Studies were conducted on 80 heads of cows of different ages in the early period of lactation. Correlation coefficient with milk protein and fat was weak ($r = 0.19$, $P < 0.01$), and negative with somatic cells ($r = -0.22$, $P < 0.01$).

Considering feeding studies, boluses with measuring the pH of the rumen are an auxiliary part of the entire milk production process, since the average positive relationship between the pH level and the average daily milk yield is determined, with an increase in acidity, milk yield decreases. The use of this system allowed to increase the number of identified animals with sexual hunting by 26.7%, to determine the calving time in 81.3% of cows.

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