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TOOLS FOR IMPROVING REPRO ON DAIRY FARMS

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Abstract

The studies presented in this article are part of the PTF of the Kazakhstan Ministry of Agriculture. Most consultants, when dealing with herd fertility problems, advise first setting specific goals (S), measurable (M), achievable (A), relevant (R), and time-bound (T) – SMART goals. Each farm has different assets, goals, and challenges and therefore a consultant must tailor their recommendations to the farm and avoid generalizations or textbook recommendations based on national averages. To create the standards for feeding, reproduction, and maintenance of dairy, during 2021-23 improved diets, assessed animal welfare, and reproduction data was collected monthly, the basis of the collected data in the article shows the dynamics of the fertility of cows in one of the basic farms participating in Execution of the program. By improving the conditions of feeding and maintenance, the fertility of cows had a positive dynamic. One of the important indicators is the number of calves per 100 cows from 77 calves in 2021 increased to 86 in 2023. The number of cows with an elongated dry period from 14.7% decreased to 6.3%. Pregnancy Rate increased by 2 times from 11.9% to 20.8%. The mortality rate of calves also decreased from 23.2% in 2021 to 6.7% in 2023. Introducing the system for heat detection cuts the heat detection rate coefficient, the indicator has grown to 54% from a low 23% in 2021. In general, we can conclude that by improving the level of feeding and maintenance, the fertility of the cows had positive dynamics.

Key words: conception rate; dairy cattle; fertility; pregnancy rate; heat detection rate.

Introduction

In Kazakhstan, many high-yielding herds suffer from the necessity to cull cows for infertility after their first lactation because the body's reserves are insufficient for milk production and reproduction [1]. This reduces the number of replacement calves, for maintaining or growing herd size. Furthermore, few replacements mean that farms must reduce their genetic selection intensity further slowing growth in the genetic value of their animals. Poor fertility means that cows spend more time in the less profitable phase of their lactation curve and compels farms to increase their annual expenses on purchasing replacement heifers, which constitutes a significant portion of their costs. Finally, low fertility necessitates numerous attempts by farmers to inseminate cows (especially first-calf heifers), which ultimately need to be culled, meaning that financial resources are wasted, thereby reducing the profitability of production.

In Kazakhstan, there has been growth in the population of cattle. In 2013, the cattle population numbered 5.7 million head, and by 2022, it had increased to 8.4 million head. As of August 2023, there was a 4% further growth, bringing the total to 8.9 million heads. The production of cow's milk has also been on the rise. In 2013, approximately 2.7 million tons of milk were produced, while in 2022, production reached around 4.0 million tons [2]. It's worth noting that a significant portion of the dairy cattle population is in small-scale family farms, and more than 70% of the total milk production comes from these smaller herds. Despite the noticeable growth in cattle numbers and milk production, the country's increasing population has led to a higher demand for livestock products, including milk with demand now exceeding 6.0 million tons annually. This represents a cost to consumers and a missed economic opportunity for the dairy sector.

The primary goal of a reproductive management program at a dairy farm is to ensure that cows calve once a year to maximize economic efficiency. However, reproductive management goes beyond just breeding cows. A successful reproductive management program encompasses overall animal management, the application of technical skills, and sensible decisions regarding breeding that fit with the economic goals of the farm. The good news is that the lower the fertility, the more the farm can spend on reproductive management and still see a positive return on their investment. Those farms with very high fertility must be careful with their spending decisions as each additional percentage improvement in fertility will return less profit. In these cases of

Materials and Methods

Reproduction data were collected monthly from the beginning of the program and at the end from each base farm. All the data that was accumulated monthly is described below.

Fertility in dairies is conveniently expressed as pregnancy rate (or pregnancy risk to insemination). However, it is important to remember that there are two factors that are involved in the pregnancy rate calculation – heat detection rate (HDR) and conception rate (CR). HDR is calculated by dividing the number of animals detected in heat (typically over a 21-day period) by the number eligible to be detected in heat (e.g., beyond the voluntary waiting period and not inseminated or pregnant). Conception rate is calculated by dividing the number of pregnant cows by the number inseminated (over 21 days). The product of HDR and CR yields the farms' pregnancy rate (PR). When PR is low, in most cases, inadequate heat detection is the primary factor. Cows not cycling at the end of the voluntary waiting period and missed heats are key factors contributing to extended calving intervals. By improving heat detection and ensuring cows are cycling by the end of the voluntary waiting period, calving interval will be reduced. Here again, the focus should be on managing the cows to successfully navigate calving, adjust to lactation, and resume cycling. Each of these is tied closely to nutritional management. The efficiency of heat detection often (but not always) improves with increased milk production. This may seem counterintuitive but the factors (nutrition, management, welfare, health) that contribute to high milk production can also lead to improved fertility. This indicates that

high fertility, reproductive management should focus on approaches to simplify and reduce the number of tasks and labor needed to maintain high fertility.

As part of the BR10764965 program, the scope of which included the preparation of standards for feeding, reproduction and maintenance of dairy cows, large-scale studies were carried out on the base farms cows' reproductive status.

The purpose of this study was to determine the dynamics of reproduction indicators with improved feeding and maintenance conditions during 2021-2023. The consultants for this project were distinguished professors of dairy nutrition Pr. A. Hristov and reproduction Pr. T. Ott at the Pen State.

producers can achieve higher milk yields along with good reproductive performance. However, it is possible to achieve high milk production, but still struggle with low fertility. The key to understanding this conflict between production and reproduction is understanding that the animal will suppress key reproductive hormones (e.g. Luteinizing hormone that causes ovulation) when it is losing weight (negative energy balance). A negative energy balance suppresses cyclicity, so no matter how diligent the heat checking, few heats will be detected. It is also important to note that high-producing cows in hot conditions, or those that are housed on slippery floors will exhibit less estrous behavior. Therefore, managing for optimal HDR rate requires farmers to feed animals so they return to positive energy balance early after calving (within 4 weeks) and institute management practices that will promote expression and detection of heats. Ovulation synchronization protocols (described below) can be used to induce ovulation in cows that are not cycling, but conception rates to these induced ovulations are low and cows will often not recycle if they do not conceive after insemination.

Goals for optimal heat detection are to observe 70% of all expressed heats and to ensure optimal nutrition so that all cows are cycling by 40-50 days after calving. If conception rates are high (>40%), cow should be inseminated 60-70 days after calving. If conception rates are low (<35%) breeding cows expressing strong heats can occur >50 days after calving. For well-managed dairies using Holstein genetics, the target for days between calving and the next conception are 110-120 (days

open). Therefore, the higher the conception rate, the later the cows can be scheduled to receive their first insemination.

Submitting animals to insemination, whether based on estrus detection or ovulation synchronization, to ovulate a high-quality follicle is only the first step to successful reproductive management. These animals must be inseminated using the appropriate techniques with high quality sperm. If both are accomplished, then the only remaining limit to high fertility is the genetic value of the animals. Measuring success of the reproductive management at this point is done by calculating the conception rate. Various estimates of conception rates include services per pregnancy and the percentage of successful services or pregnancy risk to insemination. These metrics include data from both pregnant and non-pregnant cows. The conception rate is determined by dividing the number of successful services (confirmed pregnancies) by the total number of services rendered in each interval. Confirmed pregnancies are employed to calculate this percentage in herds that routinely conduct pregnancy diagnoses. In cases where actual pregnancy data are unavailable, the 65-day non-return rate is utilized as a substitute. This approach has risks in farms using induced ovulation or where nutrition is not optimal. Cows in these situations will often fail to recycle after a failed insemination. These cows will cause a large

economic loss for the producer as the eventual determination of their non-pregnant status places them at high risk for culling.

Conception rate is an essential metric for evaluating the reproductive performance of a dairy farm. It measures the percentage of inseminated cows that become pregnant. Conception rate is determined as follows:

- Define the Time Period: Decide on the specific time frame for which you want to calculate the conception rate. It could be monthly, quarterly, annually, or any other period that suits your analysis. Monthly is recommended and fits into management practices that include pregnancy diagnosis 4-6 weeks after insemination. Longer intervals, again allow problems to accumulate before they are detected (e.g. poor-quality semen, poor insemination technique, problems with equipment etc.),

- Determine the Number of Cows Inseminated: Count the total number of cows that were inseminated during the chosen period.

- Count the Number of Pregnant Cows: Determine how many of the inseminated cows have become pregnant within the same time frame. These are the cows that have successfully conceived.

- Calculate the Conception Rate: Use the following formula to calculate the conception rate as a percentage:

$$\text{Conception Rate (\%)} = (\text{Number of Pregnant Cows} / \text{Number of Inseminated Cows}) \times 100$$

For example, if you inseminated 200 cows in a month and 140 of them became pregnant during that month, your conception rate for that month would be:

$$\text{Conception Rate} = (140 / 200) \times 100 = 70\%$$

This means that 70% of the cows you inseminated in that specific month successfully conceived.

Monitoring the conception rate over time is crucial for assessing the effectiveness of your dairy farm's reproductive management program and making necessary adjustments to improve herd fertility. Also, it is recommended that animals are rechecked for pregnancy 2-3 times before dry off. For example, 5-10% of cows identified pregnant between 30-35 days after insemination will lose those pregnancies and be open at a 60-day pregnancy. Lack of follow up pregnancy diagnosis will increase cows detected open at dry off. These cows will be culled at a large economic loss to the producer.

Pregnancy rate is another important metric for assessing the reproductive performance of a dairy farm. It measures the percentage of eligible cows that become pregnant within a specified period. Calculate the Pregnancy Rate: Use the following formula to calculate the pregnancy rate as a percentage:

$$\text{Pregnancy Rate (\%)} = (\text{Heat Detection Rate} \times \text{Conception Rate}) \times 100$$

For example, if you have 500 eligible cows in your herd during a specific month, and 350 of them are detected in heat and are inseminated then the HDR = 70% ($350/500 = 0.7 \times 100 = 70\%$). Now, if 125 of these cows are diagnosed as pregnant, the

CR = 35% ($125/350 = .35 \times 100 = 35\%$). Therefore, the pregnancy rate for that month would be:

$$\text{Pregnancy Rate} = (0.7 \times .35) \times 100 = 24.5\%$$

This means that 24.5% of the eligible cows in your herd were detected in heat, inseminated, and

became pregnant during that specific month.

Average open days between calving and the next conception (days open) serve as an indicator of the reproductive efficiency in a dairy herd. However, because this metric is measured months after insemination. It is not the most current metric for assessing the reproductive performance of a dairy. The Voluntary Waiting Period VWP represents the minimum desired interval from calving to the first service. VWP is set based on the conception rates on a farm. The higher the conception rates, the longer the VWP. In well-managed dairies with high CR, VWP is set between 70-80 days. By delaying insemination, cows have more time to adjust to lactation, recover uterine health, and cycle several times before insemination. All of these will improve CR to first insemination. This is particularly true for first calf heifers who are still growing and take longer to adjust to the metabolic demands of lactation. Because these animals have a more persistent lactation curve, the optimal days open is 10-15 days longer than that for mature lactation cows. The calving interval, measured in months, is the time elapsed between consecutive

Results

During the program, a lot of work was done to determine the fertility level of all farms involved in the research. Our statistics show that most farms in Kazakhstan have very low reproductive rates of cows. The calving interval is at least 470 days (the benchmark for dairy is 390-420 days), and in some high-producing herds, it is about 500 days. The calving interval is primarily extended due to the number of open days after calving, even when using estrus/ovulation synchronization, the number of open days ranges from 108 (optimal) to 174 (low fertility) days. This can be related to low HDR, which varies between 35-59% in Kazakhstan. The proportion of animals conceiving to the first insemination also varies widely; for cows, it is in the range of 26-56%, and for heifers – 25-82%. Optimal first-service conception rates are 45-50% for lactating cows and 60-75% for dairy heifers. The only indicator that is close to optimal in Kazakhstan is the dry period, on average 64-77 days.

Nutrition is the leading factor driving herd milk production and fertility. Heifer development is a key factor in well-managed dairies. Dairy breeds should achieve puberty between 10-12 months of age, but they must also achieve $\sim 2/3$ of their mature body size before breeding should

calvings. To calculate the projected minimum calving interval, one adds 280 days (the average length of pregnancy) to the average days open and divides the result by 30.4 days (the average month length).

The Dry Period is defined as the days between dry off and the subsequent calving. Both excessively long and short dry periods have negative implications for herd profitability. It is advisable to maintain a high proportion of cows within the 40-70-day dry period range. A short dry period deprives cows of adequate rest and recovery time for mammary gland involution and regeneration. Conversely, extended dry periods result in a prolonged period without milk income and increase the risk of over-conditioned (fat) cows. Over-conditioned cows are more susceptible to health and reproductive issues and are particularly susceptible to calving complications. The duration of dry periods, whether too long or too short, may arise from factors such as extended calving intervals, subpar record-keeping practices, or ineffective pregnancy diagnosis methods.

be attempted. Poor nutrition means that farmers cannot inseminate heifers on time because of delayed puberty and low body weight. The first insemination occurs late on average at the age of 16.8-24.6 months, and the first calving occurs at the age of 26.4-35.8 months. Here again, modern dairy breeds should be managed to conceive between 12-15 months of age and calve between 21-22 months. Low fertility (19-27% of culled cows) is second only to low production as the cause of culling in Kazakhstan. In most cases, culling occurs after the first calving due to low fertility. This is particularly devastating to farmers as it takes roughly 2.5 lactations to recover the cost of raising that heifer until she enters the milking herd. Animals culled before this represent a large economic loss to the dairy. It is obvious why in Kazakhstan the dairy business is not profitable for everyone.

The first thing you need to start with is to determine the structure of the herd. In dairy cattle breeding, the main share of the herd will be dairy cows; their share should be at least 55-60%. In dairy farming, AI is mainly used, bulls should not be included in the main herd, and younger bulls are subject to sale, not only because they are an extra cost, but at the same time, males are dangerous.

We carried out an analysis of reproduction over 3 years in an experimental farm in the Akmola region, in which basic research was carried out to

improve feeding and maintenance technologies; data on the dynamics of fertility indicators are presented in the following table.

Table 1 – Dynamics of fertility indicators from 2021 to 2023

Indicators	Goal	2021	2022	2023
# Calves per 100 cows	>90	77	80	86
% Culled cows for Repro	<10	6	20	10
% Dry cows:				
< 40 days	<5	4,4	6,7	3,9
> 70 days	<5	14,7	8,7	6,3
Pregnancy Rate (%)	>22	11,9	13,2	20,8
Calving Interval (months)	12-14	19,3	19,9	17,8
% First Service by 85 DIM*	>90	34,9	54,7	76,1
First Service Conception Rate (cows/heifers)	>45/65	19/33	10/50	28/60
Age of first insemination of heifers, months.	12-15	18	19,2	15,9
% Stillborn calves	≤3	7,8	10,4	8,6
% Calf mortality	≤7	23,2	13,3	6,7
% Calving Difficulty (4-5 on scale of 1-5)	<5	4	3	2

* Day in Milking

The farmer explained the low level of reproductive function by the fact that the level of feeding in previous years was low. Analysis of feed and feeding and housing systems confirmed the farmer's words. As mentioned earlier, cow fertility is influenced by many factors. The productivity of cows, compared to the beginning of 21, decreased from 6360 kg to 5998 kg, by the end of 2022 it had already reached 5708 kg, and at the end of the research it increased again to 6144 kg. At the same time, we see improvements in reproductive function within 3 years, in other words, with proper management of feeding and housing technology, not only productivity increase, but also the cows will not experience stress, which does not affect other functions. In 2021, the calf yield per 100 head was low at 77 per 100 head, which was aggravated by a high proportion of stillborn calves and mortality before 2 weeks of age. If we also consider the fact that this year many young animals left the herd at an earlier age, then the percentage will decrease, the number will drop to 30 calves per head. At the beginning of 2022, many cows continued to retire from the herd due to low productivity of more than 70%, but at the same time 20% of first-calf heifers left due to low fertility. In 2022, the calf yield increased by only 3%, and by 2023 it was close to the norm.

On average, the dry period for cows was within normal limits in all years, but the table shows that

in 2021, many cows were started on their own, ceasing to be productive long before calving. The launch of cows is currently being carried out in a timely manner; there are fewer cows that were milked longer, and at the same time the number of self-starting cows has decreased by more than 2 times. The calving interval has also been reduced by 2 months. The period between calving and the first insemination has also shortened to 58.8 days. The age of first insemination of heifers also approached the norm, reaching 15.9 months.

During the study period, 200 Smax Tec [3] boluses were installed on the farm, which doubled the heat detection rate. If at the beginning of the studies this figure was within 23%, then by the end of the studies it increased to 54%. Although this figure increased by more than 30%, this number is also not a reference for dairy farming; we explain this by the fact that boluses were installed only for first-calf heifers, which make up a little more than 1/3 of the entire herd.

Associated with the heat detection rate is the pregnancy rate. So, in 2021, this figure was equal to 11.9%, in 2022 it increased, but here it is worth noting that the fertilization rate in cows became below 10%, and in heifers above 50%, but due to this, the percentage of detection of cows in heat The pregnancy rate increased and increased to 13.2%. Already in 2023, these two related indicators increased, the first to 20.8%, and the second to

28/60 in cows/heifers. Thus, these two indicators make it possible to cover and understand not only the level of fertility of queens, but also the level of management of the fertility of a given herd.

Having analyzed the level of reproductive management in the herd, the next important step is to develop a plan to achieve the goals. The plan should contain clear and detailed objectives, defining who will be responsible for their implementation, what exactly needs to be done, in what time frame, in what place, and how to achieve each goal. These goals should be closely linked to the overall breeding strategy. A suitable person should be assigned to each task. Everyone involved should be trained and then be retrained/

Discussion

Milk, or more precisely, its quantity, is the sole goal of the owner since it is the primary source of income for dairy operations. Many authors have reported a negative correlation between milk production and the fertility of cows [4,5]. However, the genetic correlation between these two traits is quite low [6,7]. In fact, it is typical to see some of the best herds in terms of milk production exhibiting the best fertility. What this reveals is that farm/animal management has the greatest impact on both traits.

In practice, it is difficult to increase milk production without the proper number of high-quality replacement heifers. For instance, their review titled "A 100-Year Review: Practical

Conclusion

In conclusion, the dairy industry in Kazakhstan faces significant challenges when it comes to the reproductive rates of cows, leading to extended calving intervals, low conception rates, and high culling rates due to fertility issues. These challenges are exacerbated by various factors, with poor nutrition playing a pivotal role. Inadequate heifer development, delayed puberty, and low body weight contribute to delayed breeding, resulting in late first inseminations and calvings. Low fertility, often leading to culling after the first calving, is a major economic setback for dairy farmers, taking multiple lactations to recover the investment made in raising heifers.

In 2021, the economy faced serious problems in practically all indicators of assessing the

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evaluated at yearly intervals. Establishing a reward system for successfully completing tasks and achieving goals can be helpful. The plan also needs to clearly define what will be measured, who will monitor it, what the time frame will be, and how improvements and achievements will be assessed. Be careful in how these rewards are set. For example, rewards based on increasing the percentage of cows detected in heat may encourage workers to "believe" cows are in heat when they are not. Whereas rewards for increasing the pregnancy rate over the year from 20 to 24% will return a real profit to the dairy and will justify worker incentives.

"Female Reproductive Management," highlights that in the United States, J. S. Stevenson and J. H. Britt [8] attribute the significant increase in cow productivity from 2005 to 2015, to gains in the genetic value of animals for milk production, improved feeding management, housing, reproductive control, and greater cow welfare and comfort.

As mentioned above, many factors influence the fertility of cows, but feeding [9,10] and health management [11,12] have a greater influence. Once these influences are optimized, the use of strategies to improve cow fertility will begin to have positive effects.

reproductive function. However, by 2023, significant improvements are noticeable. The number of calves per 100 cows increased to 91, exceeding the target. The percentage of cows culled for reproduction has dropped to 10%, approaching the target. The farm has also been able to reduce the percentage of dry cows falling outside the desired range. Notably, pregnancy and first service rates by day 85 improved significantly, while stillborn calves, calf mortality and calving difficulties decreased. Due to the use of technology for raising heifers, the time of rearing before the first insemination has also been reduced. If in 2021 this figure was 18 months, then in 2023 it became 15.9 months.

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