APPLICATION OF THE METHOD OF ARTIFICIAL INSEMINATION OF BREEDING STOCK COWS

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Abstract. The objectives of this study are to analyze the economic efficiency of using the method of artificial insemination of cows with semen divided by sex, ultrasound for diagnosing inseminated breeding stock livestock and diseases of reproductive function using the example of model dairy farms, which makes it possible to determine the development potential of these farms, to conduct an economic assessment of production level. Based on development materials, calculation of the effectiveness of model farms for production of milk and its processing products is presented, the possibilities of using new technologies for the automation of technological processes are shown. In the future, in research work on organization of similar model farms, an emphasis should be placed on the consideration of indicators reflecting the specifics of their functioning, as well as production and financial results of activities based on a systematic integrated approach. Currently, a significant acceleration of genetic progress in selection and breeding work is facilitated by the use of sex-separated or sexed sperm. In trials conducted in the USA on 211 farms, the fertility of Holstein heifers with sexed sperm reached 47%, Jersey - 53%. In the offspring, 89% of heifers were obtained. In Finland, insemination of cows with sexed sperm with 2 million sperm in a dose provided 20% of calving as a result of which 82% of heifers were born, while during insemination with ordinary cryopreserved sperm (15 million sperm) - 45 and 49%, respectively. The calculation proposed by the authors is based on identifying the percentage of live calves received from the number of cows and heifers of breeding age available on farms at the beginning of the analyzed year.
Экономический механизм хозяйствования

Аннотация. Задачей данного исследования является анализ экономической эффективности применения способа искусственного осеменения коров семенем, разделимым по полу, УЗИ для диагностирования осемененного маточного поголовья и болезни воспроизводительной функции на примере модельных молочных ферм, что позволяет определить потенциал развития данных хозяйств, провести экономическую оценку уровня ведения производства. По материалам разработок представлен расчет результативности модельных хозяйств для производства молока и продуктов его переработки, показаны возможности использования новых технологий по автоматизации технологических процессов. В дальнейшем в научно-исследовательских работах по организации аналогичных модельных ферм следует сделать акцент на рассмотрение показателей, отражающих специфику их функционирования, а также производственные и финансовье результаты деятельности на базе системного комплексного подхода. В настоящее время значительному ускорению генетического прогресса в селекционно-племенной работе способствует использование разделённой по полу или сексированной спермы. В испытаниях, проведённых в США на 211 фермах, оплодотворяемость голштинских коров сексированной спермой с 2 млн сперматозоидов в дозе обеспечено 45% отёлпов, в результате которых родилось 82% тёлок, в то время, как при осеменении обычной криоконсервированной спермой (15 млн сперматозоидов) – 45 и 49%, соответственно. Расчет, предложенный авторами, основан на выявлении процента полученных живых телот от числа коров и телок случайного возраста, имеющихся в хозяйствах на начало анализируемого года.

Key words: agriculture, dairy farming, breeding stock of cows, model dairy farms, production, milk, economic efficiency.

Түйінді сөздер: ауыл шаруашылығы, сүтті мал шаруашылығы, сиырлардың аналық басы, модельдік сүт фермалары, ендіріс, сүт, экономикалық түмінділік.

Ключевые слова: сельское хозяйство, молочное скотоводство, маточное поголовье коров, модельные молочные фермы, производство, молоко, экономическая эффективность.

Introduction. One of the priority areas of the AIC of Kazakhstan is livestock production development, especially dairy farming, the efficiency of which is largely determined by the state of reproduction of cattle herd. The high productivity of cows, capable of using nutrients for milk biosynthesis with maximum efficiency, is due to the intensity of metabolic processes and the intense functioning of all systems and organs [1].

In recent years, the process of introducing new technologies in this industry has intensified, but it should be noted that when using innovative technologies for milk production, animals are placed in harsh conditions, stress loads and predisposition to
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gynecological diseases have increased, and individual control over the state of reproduction function has become more complicated.

The increase in livestock production directly depends on stabilization of the cattle population in dairy farms, technologically justified raising of replacement young animals and growth of animal productivity. The system of these measures requires not only complete feeding and proper maintenance of cows, but also the use of a clear science-based system for monitoring and regulating reproductive function. So, to date, a significant acceleration of genetic progress in selection and breeding work is facilitated by the use of artificial insemination of cows with semen separated by sex and ultrasound for diagnosing inseminated breeding stock is justified based on the data from specific model dairy farms.

Material and methods of research. In conducting these studies, various methods of economic research were used: economic-statistical, abstract- logical, monographic, computational and constructive, etc.

In order to conduct an economic assessment of the effective use of the method of artificial insemination of cows with semen separated by sex, pregnancy of the inseminated breeding stock was determined and diseases of reproductive function were diagnosed using ultrasound. The calculation was based on identifying the percentage of live calves received from the number of cows and heifers of breeding age available on farms at the beginning of the analyzed year.

The calculation of economic efficiency of early pregnancy detection made it possible to reduce costs, since every day of infertility brings losses to the farm, resulting from the lost milk, lost calf and cost of keeping a barren cow.

The obtained results were processed and analyzed using financial and economic methodology, since economic effect, or financial component of the study, plays a significant role here. In the process of studying model farm that uses technologies aimed to automate technological processes in dairy production, to conduct more detailed determination of the advantages of new technology and economic effect of its implementation.

Moreover, calculation of the efficiency of milk production using advanced technologies is based on assessment of potential benefits from its sale, as a share of total sale effect, which is determined for each technology individually.

Results and their discussion. The experience of the achievements of developed countries in selection and breeding works confirms the high efficiency of using artificial insemination of cows with semen separated by sex or sexually sperm, and its significant impact on the acceleration of genetic progress. Thus, in trials conducted in the USA on 211 farms, the fertility of Holstein heifers with sexed sperm reached 47%, Jersey heifers - 53%, 89% of heifers were obtained in the offsprings. In Finland, insemination of cows with sexed sperm with 2 mln sperm in a dose provided 20% of calving, as a result of which 82% of heifers were born, while when inseminated with conventional cryopreserved sperm (15 mln sperm) - 45 and 49%, respectively. Sexed semen, depending on technology of its production, guarantees the yield of 90 to 75% of calves of the required sex [see. 2].

Determining pregnancy is an important economic component of a model dairy farm. There are several methods for diagnosing cow pregnancy: rectal, hormonal and ultrasonic. In rectal method, the specialist can identify pregnancy from the second month. Rectal examinations are safe from two months onwards, due to a rather high error rate. Hormonal, laboratory method - allows to determine pregnancy on 19-23 days after insemination. This method works well and is safe for the cows' health, but it takes more time compared to ultrasound diagnostics - one need to take milk samples or blood tests, make analysis, when determining the level of the hormone, it is important to consider that this method requires the creation of appropriate laboratory conditions, purchase of immune enzyme analyzer and monthly financial costs for consumables [see 2].

Ultrasound - diagnostics using an ultrasound scanner allows to make more accurate diagnoses at an earlier stage of 35-42 days, of course one can determine pregnancy on 28-35 days after insemination, but there is a risk of embryonic mortality, in addition, scanners help to detect gynecological problems and diseases rather than traditional manual palpation starting from day 60, as it is done in many farms. With the help of ultrasound diagnostics, it is also possible to determine the residual corpus luteum, which prevents ovulation of follicles (release of the egg cell), follicular and luteal cysts, hippofunction and a number of other gynecological diseases [3].
In addition, using ultrasound, it is possible, without knowing the date of insemination, to determine the age of fetus, which will allow to launch the animal in a timely manner and properly prepare for calving, which will allow the cow to recover faster after calving, reach the peak of productivity and become pregnant earlier.

One of the advantages of ultrasound diagnostics of pregnancy is also the speed of work - an experienced specialist spends from 30 seconds to 1 minute per cow, while in rectal method it may take 3 - 5 minutes or more. Previously, a doctor could fill with rectal palpation, and with the help of ultrasound scanner he can see, which means he can make more competent diagnosis and prescribe correct treatment. For example, endometritis at the initial stage of inflammation cannot be palpated by hand, so this method will allow prescribing appropriate treatment at an early stage of the disease, checking the result of particular hormonal scheme, determining pregnancy at 35 days, and significantly shortening the service period [see 3].

In the course of the study, in order to conduct an economic assessment of the effective use of the method of artificial insemination of cows with sex separated semen, pregnancy of the inseminated breed stock was determined and diseases of reproductive function were diagnosed using ultrasound. The calculation was based on identifying the percentage of live calves received from the number of cows and heifers of breeding age available on farms at the beginning of the analyzed year. Calculation of economic efficiency of early pregnancy detection made it possible to reduce cost of keeping livestock (barren cow); every day of infertility brings losses to the farm, which result from not received milk (NR) or not received calf.

NR milk is calculated (in monetary terms) according to following formula [4]:

\[
\text{Average milk yield kg/day} \times \text{cost of milk kg/tg} = \text{NR milk, tg}
\] (1)

The cost of a calf born by dairy cows (NR calf) is determined by the formula:

\[
3.61 \times \text{cost of 1 calf of milk tg} = \text{NR calf, tg.}
\] (2)

where 3.61 - the amount of milk that can be received due to feed used for obtaining a calf from dairy cows;

The cost of 1 calf of milk - the price of 1 calf of milk of basic fat content. So 1 day of infertility of a cow on dairy farm costs:

\[
\text{NR calf, tg / 280 = cost of 1 day of infertility, tg/day}
\] (3)

The cost of keeping a barren cow mainly consists of the feed day cost. The feed day cost, in turn, consists of the cost of daily ration, as well as the cost of care and maintenance.

The loss per day from each barren cow is calculated using the following formula:

\[
\text{Feeding day cost, tg/day + care and maintenance costs, tg/day + cost of 1 day of infertility, tg/day = loss per day from each barren cow, tg/day}
\]

The use of ultrasound to diagnose pregnancy allows to determine the result of insemination a month earlier and either re-inseminate or cull the animal. The service period is reduced by at least 30 days, that is, we begin to receive milk from the cow in the next lactation 30 days earlier.

The total loss from one barren cow for the entire reproductive cycle is calculated as follows [see. 4]:

\[
30 \text{ days} \times \text{loss per day from each barren cow} \times \text{total loss from one barren cow for the entire reproductive cycle, tg}
\]

Thus, one can calculate the payback of ultrasound scanner for a certain period of time (month):

\[
\text{Cost of ultrasound scanner, tg / total costs of barren cows, tg} \times 12 \text{ months} = \text{return of ultrasound scanner, months}
\]

The above indicators were calculated on the basis of model dairy farms: IB “Karimov” [5], APC “Plemzavod Almaty” [6], LLP “Tastobe Agrofud” [7], IB “Sadykov” [8] Almaty region, LLP “Borte Milka”[9] Turkestan region, PF “E. Zaytenov”[10] East Kazakhstan region, LLP “Kakpatas-Kordai”[11] Zhambyl region.

To ensure technological rhythm of herd reproduction, it is necessary to receive monthly 9-10% of calving from the livestock of the farm (complex), to carry out 14-16% of inseminations at 55-60% fertility. For such a rhythm of reproduction, not only complete feeding and proper maintenance of cows are required, but also the use of a clear scientifically grounded system of control and regulation of reproductive function [12].

Thus, economic assessment of the effective application of the method of artificial insemination of cows with sexed semen
the same time, cost of semen in the structure of
turned out to be profitable and amounted to
additional income: in IB "Karimov" - 3937
thous. tenge, LLP "Kakpatas-Kordai" - 2614
thous. tenge, APC "Plemzavod "Almaty" - 7151
thous. tenge, LLP "Tastobe Agrofood" - 3054
thous. tenge, IB "Sadykov" - 1949 thous.
thous. tenge, LLP "Borte Milka" - 3716 thous. tenge
and PF "E. Zaytenov"- 4121.7 thous. tenge. At

Table 1 - Economic assessment of the effective application of the method of artificial insemination of
cows with sex separated semen in the surveyed model dairy farms

| Indicator                                      | IB "Karimov" | LLP "Kakpatas-Kordai" | APC "Plemzavod "Almaty" |
|------------------------------------------------|--------------|------------------------|-------------------------|
| Average cost of 1 dose, tg                     | 9 500        | 9 500                  | 9 500                   |
| Insemination costs per 100 heifers, tg.       | 950 000      | 950 000                | 950 000                 |
| Calf yield per 100 cows.                      | 23           | 32                     | 23                      |
| Calves output per 100 fruitfully inseminated cows, head. | 21 | 30 | 24 |
| The cost of semen in cost structure of 1 calf, tg | 41 304 | 29 688 | 41 304 |
| Semen costs, thous. tenge                      | 867,4        | 890,6                  | 991,3                   |
| Duration of use of animals, months (lactations) | 36 | 72 | 72 |
| Milk yield on average per lactation, kg        | 324 000      | 223 059                | 511 920                 |
| Cost of milk sold, thous. tenge                | 39 852       | 26 767,1               | 71 668,8                |
| Cost of milk sold, thous. tenge including semen cost | 38 984,6 | 25 876,5 | 70 801,4 |
| Additional income, thous. tenge                | 3 937        | 2 614                  | 7 151                   |

Note: Compiled by the authors based on researches

Table 2 - Economic evaluation of the effective application of the method of artificial insemination of
cows with semen separated by sex in the surveyed model dairy farms

| Indicator                                      | LLP "TASTOBE AGROFOOD" | IB "SADYKOV" | LLP "BORTE MILKA" | PF "E. ZAYTENOV" |
|------------------------------------------------|------------------------|--------------|-------------------|------------------|
| Average cost of 1 dose, tg                     | 9 500                  | 9 500        | 9 500             | 9 500            |
| Insemination costs per 100 heifers, tg.       | 950 000                | 950 000      | 950 000           | 950 000          |
| Calf yield per 100 cows.                      | 90                     | 29           | 54,6              | 41,7             |
| Calves output per 100 fruitfully inseminated cows, head. | 45 | 24 | 51,3 | 20,3 |
| The cost of semen in cost structure of 1 calf, tg | 10 556 | 32 759 | 17 399 | 22 781,8 |
| Semen costs, thous. tenge                      | 475                    | 786,2        | 892,6             | 462,5            |
| Duration of use of animals, months (lactations) | 36 | 72 | 36 | 72 |
| Milk yield on average per lactation, kg        | 255 960                | 223 200      | 314 028           | 349 344          |
| Cost of milk sold, thous. tenge                | 30 715,2               | 20 088       | 37 683,4          | 41 271,4         |
| Cost of milk sold, thous. tenge including semen cost | 30 240,2 | 19 301,8 | 36 790,8 | 40 809 |
| Additional income, thous. tenge                | 3 054                  | 1 949        | 3 716             | 4 121,7          |

Note: Compiled by the authors based on researches
Как результат исследований, искусственное оплодотворение коров с семеном, полученным от американских быков селекции Welcome gervase-et 501ho10247-66757435 линии Prestige, было проведено у коров в течение 3 месяцев. Накопление живой массы (347 ± 0,41 кг) у коров, оплодотворенных искусственно, составило 247 ± 7,4 кг. В процессе генитального осмотра, который проводился в течение 2,5 последующих циклов (цикл = 21 день), количество оплодотворенных коров, которые не были оплодотворены или были оплодотворены неправильным способом оплодотворения, оставалось не оплодотворенными. Акустический сканер позволил определить беременность через 31,5 дня после оплодотворения животных.

Табл. 3 - Средний репродуктивный потенциал коров в исследованных модельных молочных фермах в разные сезоны года

| Индикатор                        | Осень | Лето   | Весна |
|----------------------------------|-------|--------|-------|
| Срок оплодотворения, дни         | 142   | 150    | 145   |
| Процент оплодотворенных коров    | 40    | 47     | 42    |
| Процент коров, не оплодотворенных натурализованных    | 2     | 1,5    | 1,1   |
| Процент коров, не оплодотворенных абортами | 2,2   | 0,4    | 0,9   |
| Процент коров, не оплодотворенных  | 2     | 1      | 2,5   |
| Среднее живое масса телят (при рождении), кг | 34±0,46 | 34±0,46 | 33±0,26 |
| Молочная продуктивность, кг      | 235±7,4 | 220±6,8 | 450±9,0 |
| Соматические клетки, тыс. / мл   | 209±4,2 | 292±4,8 | 188,6±3,8 |

Примечание: данные составлены авторами на основе исследований.

Ультразвуковые сканеры привлекательны для ферм, в первую очередь, из-за возможности раннего определения беременности, особенно в случае использования ультразвукового сканера. Традиционный генитальный метод позволяет определить беременность через 31,5 дня после оплодотворения животных, но не оплодотворенных или оплодотворенных неправильно. Традиционный генитальный метод позволяет определить беременность через 2,5 последующих цикла (цикл = 21 день) и оставаться не оплодотворенными, а также определить срок оплодотворения на следующий после определения течение 52,5 дней.

При использовании ультразвука, срок оплодотворения коров определялся через 35 дней после оплодотворения.

Табл. 4 - Сравнительный анализ экономической эффективности использования ультразвукового сканера и традиционного ректального метода

| Имя                             | Ректальный метод | Ультразвуковой сканер |
|---------------------------------|-----------------|----------------------|
| Затраты на содержание неродившей коровы в день, тенге | 1630            | 1 630                |
| Цикл                            | 2,5             | 1,5                  |
| Дни                            | 52,5            | 31,5                 |
| Общие затраты за цикл, тенге     | 85 575          | 51 345               |

Примечание: данные составлены авторами на основе исследований.

Анализ экономической эффективности использования ультразвукового сканера для диагностики оплодотворенных животных в модельных фермах показал, что при условии оплодотворения коров, если животные не были оплодотворены, потери от каждой неродившей коровы составили: в IB "Karimov" - 3,419 тг, LLP "Kakpatas-Kordai" - 3,355 тенге; APC "Plemzavod Almaty" - 3 423 тенге, LLP "Tas-tobe Agrofud" - 3 395 тенге, IB "Sadykov" - 3 395 тенге.
The calculation of economic efficiency of early detection of pregnancy shows cost reduction resulting from the lost milk: in IB “Karimov” - 2 850 tenge, LLP “Kakpatas-Korday” - 900 tenge, APC “Plemzavod “Almaty”- 1 948 tenge, LLP “Tastobe Agrofud”- 2,163 tenge, IB “Sadykov”- 622 tenge, LLP “Grofud”- 820 460 tenge, APC “Plemzavod “Almaty”- 3,392 tenge, PF “E. Zaytenov”- 1 283 tenge per day, the lost calf on average in seven farms - 43 747.7 tenge.

Thus, the cost of keeping barren cows for the entire reproductive cycle averaged 101.3 thousand tenge per head of cattle, the cost of keeping barren cows on average for seven surveyed farms amounted to 1162.7 thousand tenge (tables 5.6).

Table 5 - Calculation of the economic efficiency of early detection of pregnancy using ultrasound scanner in 7 model dairy farms

| Indicator                                      | IB “KARIMOV” | LLP “KAKPATAS - KORDAY” | APC “PLEMZAVOD” ALMATY “ |
|------------------------------------------------|--------------|--------------------------|---------------------------|
| Sexed semen                                    | 1 000 080    | 1 000 080                | 3 000 000                 |
| Cost of an ultrasound scanner, tenge           |              |                          |                           |
| Number of cows, heads                          | 400          | 194                      | 1 522                     |
| Cost of 1 kg / tg of milk                      | 95           | 60                       | 95                        |
| Cost of 1 kg / tg of milk                      | 123          | 120                      | 142                       |
| Not received milk, tg / day                    | 2 850        | 900                      | 1 948                     |
| Not received calf, tg                          | 44 403       | 43 320                   | 51 262                    |
| Loss per day from each dry cow, tg / day       | 3 419        | 3 355                    | 3 423                     |
| Total loss from one barren animal for the entire reproductive cycle, tenge | 102 557     | 100 641                  | 102 692                   |
| Number of identified cows, heads               | 8            | 4                        | 30                        |
| Total costs of barren cows, tenge              | 820 460      | 390 489                  | 312 9487                  |
| Payback of ultrasound scanner, month           | 15           | 31                       | 12                        |

Note: compiled by the authors based on research

Table 6 - Calculation of the economic efficiency of early detection of pregnancy using ultrasound scanner in 7 model dairy farms

| Indicator                                      | LLP “TASTOBE AGROFOOD” | IB “SADYKOV” | LLP “BORTE MILKA” | PF “E. ZAYTENOV” |
|------------------------------------------------|------------------------|--------------|-------------------|------------------|
| Sexed semen                                    | 3 000 000              | 3 000 000    | 3 000 000          | 3 000 000        |
| Cost of an ultrasound scanner, tenge           |                        |              |                   |                  |
| Number of cows, heads                          | 629                    | 172          | 470               | 600              |
| Cost of 1 kg / tg of milk                      | 103                    | 61           | 105               | 95               |
| Cost of 1 kg / tg of milk                      | 120                    | 90           | 130               | 118              |
| Not received milk, tg / day                    | 2 163                  | 622          | 3 024             | 1 283            |
| Not received calf, tg                          | 43 320                 | 32 490       | 46 930            | 42 598           |
| Loss per day from each dry cow, tg / day       | 3 395                  | 3 246        | 3 408             | 3 392            |
| Total loss from one barren animal for the entire reproductive cycle, tenge | 101 841 | 97 381 | 102 228 | 10 1764 |
| Number of identified cows, heads               | 13                     | 3            | 9                 | 12               |
| Total costs of barren cows, tenge              | 1 281 165             | 334 991      | 960 945           | 1 221 169        |
| Payback of ultrasound scanner, month           | 28                     | 107          | 37               | 29               |

Note: compiled by the authors based on research

Conclusion.

1. The analysis of economic efficiency of using the method of artificial insemination of cows with semen separated by sex and ultrasound for diagnosing the inseminated breeding stock and reproductive function diseases on the basis of seven surveyed model dairy farms made it possible to determine the development potential of these farms, to conduct an economic assessment of production level.

2. The economic assessment of the effective application of the method of artificial insemination of cows with sexed semen turned out to be profitable and allowed the farms to receive additional income: in IB
nomic efficiency of early pregnancy detection made it possible to reduce costs resulting from the lost milk: at the IP Karimov - 2850 tenge, LLP "Kakpatas-Kordai" - 900 tenge, SPK "Plemzavod" Almaty -. 1948 tenge, LLP " Tastobe Agrofood " - 2163 tenge, IB "Sadykov" - 622 tenge, LLP " Borte Milka " - 3024 tenge and PF " E. Zaytenov " - 1283 tenge per day.

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