



Slovak international scientific journal

№48, 2020

Slovak international scientific journal

VOL.1

The journal has a certificate of registration at the International Centre in Paris – ISSN 5782-5319.

The frequency of publication – 12 times per year.

Reception of articles in the journal – on the daily basis.

The output of journal is monthly scheduled.

Languages: all articles are published in the language of writing by the author.

The format of the journal is A4, coated paper, matte laminated cover.

Articles published in the journal have the status of international publication.

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1000 copies

Slovak international scientific journal

Partizanska, 1248/2

Bratislava, Slovakia 811 03

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EFFICIENCY OF USING SEXED SPERM IN THE FORMATION OF HIGHLY PRODUCTIVE HERD OF MILKING COWS

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Abstract

The aim of the study was to study the effectiveness of the use of sexed semen on the broodstock cattle of Holstein cattle. The subjects were cows, calves, heifers, sex and normal semen. The subject of the study is reproductive indicators, fertility, calf yield.

The tasks included the analysis of the main indicators in the dairy industry of the use of sexed semen; comparative evaluation of indicators in animal husbandry when using sexed and normal sperm.

It has been experimentally established that insemination with sexed sperm accounts for 82.95% and normal sperm for 17.21% of the total number of animals. The yield of calves from insemination with sexed sperm is 55.19%, normal - 44.81%. 159 heads, or 10.38% more calves, were obtained from mating livestock with sexed semen. The use of sexed semen reduces the ability to fertilize animals by an average of 25.0%. For 1 hryvnia invested in the purchase of semen, divided by sex, the company receives a profit of UAH 7.16, which convinces of the high profitability of its use.

Keywords: sexed semen, cattle, dairy cows, economic efficiency.

Formulation of the problem. Obtaining cheap high-quality livestock products ensures the profitability of production. Intensive technologies, advanced methods of selection and reproduction are used for this purpose, genetic resources of the best world breeds of cattle are used. In recent years, with the increase in milk productivity and reduced use of cows, the problem of lack of repair heifers has become more acute [1].

It is solved by mass production in the offspring of young animals of a given sex, which allows to increase the yield of high-value heifers, timely repair a herd of

cows, increase the profitability of the industry. This innovative technology is still ingrained in Ukraine, so a few of farms use sperm, which allows you to get up to 90% of heifers in the offspring [2, 23].

The basis of the feasibility of using separated sperm is the percentage of fertilization and yield of heifers in the offspring, the intensity of their growth and development, the ability to reproduce and preserve genetic predispositions, milk productivity of first-borns compared to peers.

At all stages of the updated technology of livestock production it is necessary to maintain and multiply modern achievements in the field of breeding, keeping, feeding, milking and protection of livestock from diseases. It is necessary to constantly work on increasing the time of productive use of cows. It is especially important to objectively control productivity, improve the physiological condition of heifers and cows, reproduction, reduce infertility and udder diseases based on improving the quality of milking equipment and the use of advanced technologies [4, 8, 20, 24].

The relevance of this work is determined by the fact that in recent years in Ukraine there is not enough production of heifers needed to repair cows. In this regard, there is an urgent need to test the use of semen, divided by sex, with increased production of heifers in the offspring directly at the existing enterprise. Thus it is necessary to carry out the analysis of growth and development of the received calves, the economic substantiation of application of such system of the accelerated reproduction of uterine livestock in dairy cattle breeding on the basis of a farm of the Vinnytsia region.

Review of recent research and publications.

The technology of dividing the sperm of bulls by sex is only the first steps, suppliers of such exclusive products are still few. In Ukraine, semen divided by sex comes only from foreign companies, mainly from the United States; the main suppliers are the representative offices of the American corporations ABS Global Inc, Alta Genetics Rush and the Canadian Semex Alliance [7, 15].

Currently, the leading position in the world for the production, sale and quality of sexed sperm is occupied by the American company CRI. Products are sold in 67 countries; There is an ERCR (Family Fertilization) rating in the United States. In this ranking, CRI is consistently in first place.

Revolutionary in the field of cattle reproduction was the invention in the late 1970s by the method of flow cytometry for the separation of living cells through a high-speed sorter. In the 1980s, there were attempts to separate sperm containing X chromosomes from those containing Y chromosomes. However, at that time no positive results were obtained. And already in 1992, when using semen, divided by sex, got the first calf [6, 19].

Cogent (Great Britain) was the first in the world to use the method of dividing the sperm of breeding bulls by sex in production conditions (1999). The method of semen separation by sex was developed by X & Y Inc. (USA). It is based on the fact that gametes of bulls contain a haploid set of chromosomes. Therefore, some germ cells contain X chromosomes, while others contain Y. X gametes with an X chromosome contain 4% more DNA than sperm with a Y chromosome. By staining the chromosomes of germ cells, it was found that gametes with the X chromosome absorb 4% more dye than gametes with the Y chromosome. The level of fluorescent glow, which is captured by a computer, depends on the amount of absorbed dye [12, 21].

Breeders have found that in dairy farming is in great demand sperm, which contains the X chromosome, which determines the female sex, in meat - Y

chromosome, which determines the male sex. The efficiency obtained from the use of this technique is 65-95% of individuals of the desired sex.

Only relatively recently has science developed technology and laboratory equipment for producing sexed sperm from breeding bulls and using frozen thawed sexed sperm. Production inspection confirmed the high efficiency of sex distribution (bulls, heifers) of sperm - up to 92%. The use of sexed semen from producers also dramatically increases the intensity of selection among females and males. However, the high cost of sexed sperm and reasonable doubts of animal scientists and geneticists about the biological "harmlessness" of the proposed technology in the future, after 3-5 generations of offspring, still need to be analyzed and substantiated [14, 22].

The method of dividing families by sex was developed by X & Y Inc. (USA). Bull semen has 2 types of sperm. Some sperm (23 pairs of chromosomes) contain an X chromosome, others a Y chromosome. When a heifer's egg merges with sperm with an X chromosome, a heifer is born, when a sperm with a Y chromosome is a bull. The principle of the method of division into X and Y-sperm is based on the difference in DNA content in the X and Y chromosomes. X - sperm of male mammals contain 4% more DNA and, using a fluorescent dye and a strong photomultiplier, using flow velocity laser cytometry, it was possible to isolate fractions containing up to 92% of germ cells with X or Y chromosome [13]. This uses a non-toxic fluorescent dye.

Currently, the largest patent holders for the technology of obtaining sexed bull semen and its commercial use worldwide are the American company XY Ins (Sexing Technologies, Navasota, Texas) and the Canadian company Simex Alliance, whose official representative in Ukraine is Simex Alliance Ukraine. According to the company, the birth of offspring of a given sex using ST occurs in 90-98% of cases, and the number of selected sperm, which is necessary for effective fertilization, is less than under conventional artificial insemination. At the appropriate level of organization of cryopreservation of sequin straws containing sexed sperm, there is no loss of functional qualities of sperm.

It is established that with the use of this new biotechnological method in dairy farming of foreign countries more than 90% of heifers from 100 cows were obtained. Since sexed semen is obtained for commercial use only from the best offspring, its use provides a short time to increase animal productivity and a significant increase in their own repair livestock [16].

Simex Alliance Ukraine LLC is the exclusive Ukrainian representative of the world-famous Canadian company Simex Alliance Canada, which provides genetic products in more than 80 countries.

In Ukraine, it should be noted farms where it is used successfully. Thus, at the breeding plant of AF Glushky LLC (Bila Tserkva district, Kyiv region) they used sexed semen of the Kingley bull-breed 101409948 of the Starbuck line 352790 of the Holstein breed of the Semex Alliance manufacturer (the cost of sperm doses is UAH 256). Heifers of mating age were inseminated at the age of 15-16 months, live weight from 360 kg.

In FG "Mais" of Khmelnytsky region the percentage of fertilization with sexed sperm at the first insemination is not less than 80-83%, and receiving from them heifers - 95-98%.

Astarta-Kyiv, Khmilnytske LLC, Vinnytsia region, where the sexed semen of the Sylvester bull-breeder 3131910946 of the Chifa line 1427381 of the Holstein breed of the Simex Alliance Ukraine company was used. Heifers of mating age were inseminated at the age of 14-16 months at a live weight of 350 kg. It was found that fertility was 72%. The share of born heifers was 91%. Born heifers have good growth and development with a live weight of 35-38 kg.

Good results were obtained in LLC "Progress" Kirovograd region, which uses semen divided by sex, breeding bull Bloomfield 3130920421 line Elevation 1491007.65 Holstein breed company "Simex Alliance Ukraine". The age of heifers at the first insemination is 13-15 months. It is established that the fertilization of heifers with sexed sperm of this bull is 65%.

Due to the high cost and complexity of the process of family separation, experts have found that one sexed sperm contains 2-2.1 million male gametes, while in a straw with a normal family - 20-21 million sperm. In addition, as a result of staining with fluorescent dye reduces the energy supply of sperm, which leads to less (on average 15%) fertility of sperm compared to normal [17].

But with the use of the latest technologies for the production of sexed sperm, a new product was developed: ultrasexual sperm with a concentration of 4 million sperm, which allowed producers to maintain the rate of fertile insemination at the level of traditional sperm production. For this reason, sexed semen continues to be one of the main factors in the effectiveness of animal husbandry. This is confirmed by data on the analysis of the results of fertile inseminations of Holstein and Jersey breeds in the period 2012–2016, where the share of sex sperm use has increased significantly since 2013. The use of sexed semen on Holstein cows of the first and second lactations is becoming more common, and has practically supplanted the use of traditional semen on heifers and Jersey cows. The percentage of fertile inseminations with the use of such sperm can clearly reach 85-90% as with the use of traditional sperm [18].

Purpose and objectives. The aim of the study was to study the effectiveness of the use of sexed semen on the broodstock cattle of Holstein cattle. The object of research were first-born cows and repair heifers of mating age of Holstein breed, where sex sperm of bulls of Holstein breed is used. The objectives of this study were to study the fertility rate, the insemination index of heifers, the rates of obtaining heifers per 100 goals. calves, when using sexed and normal semen.

Materials and methods of research. The experiments were conducted by the Limited Liability Company "Ukraine" located in the village of Skoryky,

Pidvolochysk district, Ternopil region. The company leases and efficiently cultivates 14.5 thousand hectares of arable land. The crop industry specializes in growing cereals and industrial crops. The farm is the largest producer of agricultural products in the district and region. It specializes in breeding Holstein cattle. In 2018, Ukraine milked an average of 10,765 kg of milk from each of 1,140 cows, and in 2019 this figure increased to 10,870 kg per cow.

In Skoryky the main bet is made on imported selection of Holstein heifers. In 2016, 400 highly productive breeding animals were imported from Germany, and in 2018. At milking from these first-borns here receive 37–38 kg of milk per head daily. To reproduce their own livestock use exclusively sexed semen of Canadian selection, which guarantees the birth of 90% of heifers.

The farm uses milk production technologies from the Swedish company DeLaval, which provides remote control of milking processes, balanced feeding and feed distribution. The technology of artificial insemination of heifers and cows with frozen sperm of breeding bulls is performed in accordance with the recommendations of the company supplier of organic products, taking into account the reduced number of sperm in the dose.

All healthy heifers that have reached 15 months of age and were ready, are initially fertilized with divided semen once according to the technology recommended by the manufacturer of this organic product. Its main feature was that after a clear manifestation of hunting insemination was carried out by rectocervical method with a delay of 12 hours from its onset, once. Detection of heifers and cows of mating age was carried out constantly during the day, especially at night and in the morning. Re-insemination in the case of "overdose" was performed with ordinary semen (not divided by sex) [9].

During the current year, the animals are kept in a stable. The main part of their diets were haylage, silage and hay. In addition, heifers received concentrated feed, as well as mineral and vitamin supplements. Before calving for 1-3 weeks in small groups of heifers were transferred to the maternity ward.

Animals of the control and experimental groups met the requirements of the recommendations for the Holstein breed: the age of insemination of young animals averaged 15 months at a live weight of about 400 kg.

Throughout the year, the animals were kept in a stable. Before calving for 1-3 weeks in small groups of heifers were transferred to the maternity ward.

Research results. With the support of favorable microclimate conditions, loose housing and balanced milking of Holstein cows on the farm in 2019 amounted to 10870 kg with a mass fraction of fat in milk 3.7% and protein at 3.3% (Fig. 1).

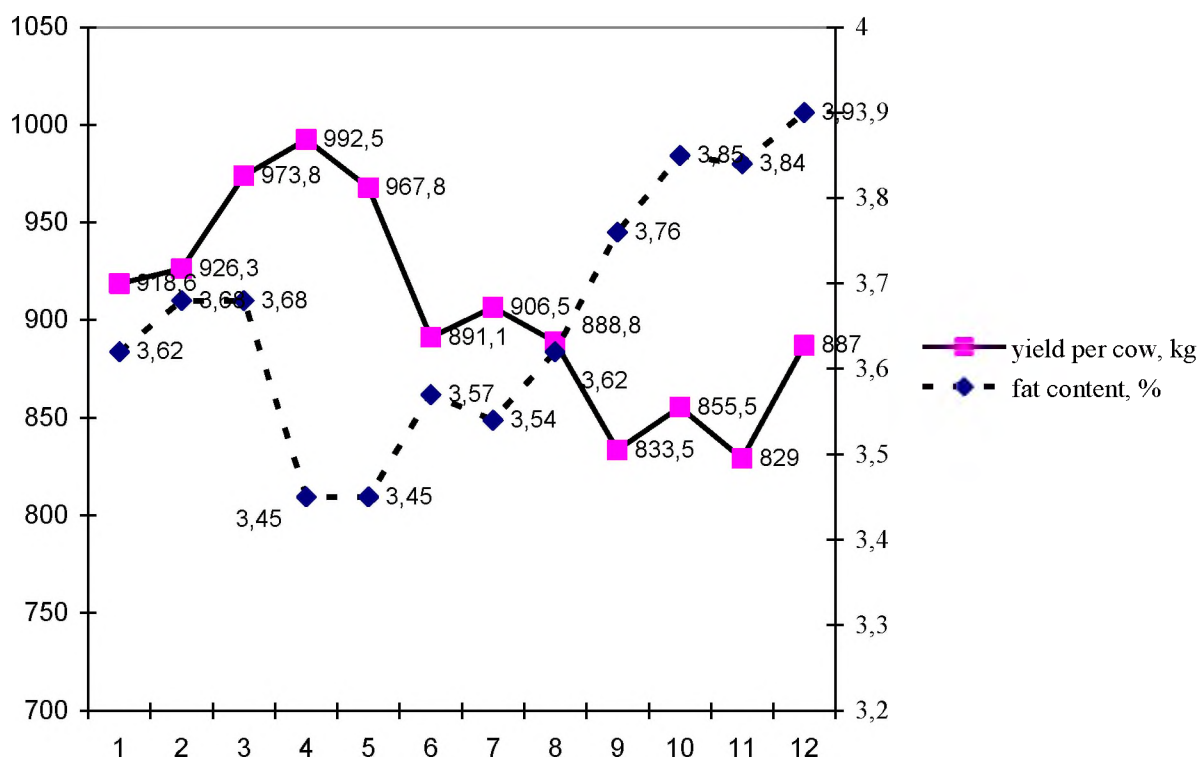


Fig. 1. Dynamics of milk productivity per cow according to 2019 data

Analyzing the graphical indicators of the dynamics of milk yield for the year, we can conclude that the peak of milk yield (992.5 kg) occurs in April, but in this period the mass fraction of fat in milk is the lowest (3.45%).

In 2019, 14,365,783 tons of milk were milked on the farm and 12,520,226 tons were sold with an average fat content of 3.7%. The marketability of milk was 87.15%. Fat content is one of the important indicators of milk quality, which is used to calculate milk (Table 1).

Table 1

Indicators of milk productivity, kg					
The month of the year	Milk sold, c	Basic milk fat sold, c	Month of the year	Milk sold, c	Basic milk fat sold, c
January	12018,97	12796,67	July	12988,78	13523,61
February	11589,30	12543,71	August	12698,70	13520,38
March	12851,77	13910,15	September	11622,27	12852,86
April	13581,22	13820,89	October	11806,55	13369,18
May	13327,98	13523,98	November	1154 0,48	13033,95
June	12715,72	13351,51	December	12293,26	14101,09
-	-	-	In a year	125201,26	160347,98

Sperm is imported to the farm from bulls: S. Bloomfield 3130920421, VH Cardinals 3130854061 and S. Kelebrat 68841724. In the farm when fertilizing heifers with sexed sperm sperm consumption is 1.3 doses per 1 heifer, and in normal - 1.1.

Sexed sperm fertilize first-born cows and more heifers, as they are better fertilized. If the heifer is not fertilized successfully from the first time, it is re-fertilized with ordinary semen. The price of 1 dose of sexed sperm is UAH 850, regular - UAH 100.

Insemination of repair broodstock with sexed sperm on the farm began in the spring of 2016. In 2019, the farm mated 1830 heads of breeding stock, of which 1143 cows and 687 heifers. Among this number of animals, 904 were inseminated with sexed semen cows, and 687 heifers, normal semen - 241 cows and 74 heifers (Table 2).

Table 2

Results of monthly mating of broodstock cattle

The month of the year	cows					heifers				
	total	Sexed sperm		Regular sperm		total	Sexed sperm		Regular sperm	
		num-ber	%	num-ber	%		num-ber	%	num-ber	%
January	85	67	78,82	18	21,18	57	51	89,47	6	10,53
February	90	71	78,89	19	21,11	79	70	88,61	9	11,39
March	95	75	78,95	20	21,05	83	74	89,16	9	10,84
April	103	82	79,61	22	21,36	71	63	88,73	8	11,27
May	104	82	78,85	22	21,15	58	52	89,66	6	10,34
June	99	78	78,79	21	21,21	51	46	90,20	6	11,76
July	95	75	78,95	20	21,05	48	43	89,58	5	10,42
August	92	73	79,35	19	20,65	48	43	89,58	5	10,42
September	93	74	79,57	20	21,51	48	43	89,58	5	10,42
October	92	73	79,35	19	20,65	48	43	89,58	5	10,42
November	95	75	78,95	20	21,05	48	43	89,58	5	10,42
December	100	79	79,00	21	21,00	48	43	89,58	5	10,42
In a year	1143	904	79,09	241	21,08	687	614	89,37	74	10,77

The monthly population of cows that were inseminated was in the range of 85-104 heads, heifers - 48-83 heads. Most heifers were mated in February (79), March (83) and April (71). Of the number of paired an-

imals, 67-82 heads were inseminated with monthly semen. cows (78.82-79.61%), heifers - 43-63 heads. (88.61-90.2% of the total population).

In general, in 2019, significantly more broodstock was mated with sexed sperm than regular - 1518 heads (82.95%) compared to 315 heads (17.21%) (Table 3).

Table 3

Results of mating of uterine cattle with sexed and normal semen

The month of the year	Inseminated				
	Total	Sexed sperm		Regular sperm	
		гол.	%	гол.	%
January	142	118	83,10	24	16,90
February	169	141	83,43	28	16,57
March	178	149	83,71	29	16,29
April	174	145	83,33	30	17,24
May	162	134	82,72	28	17,28
June	150	124	82,67	27	18,00
July	143	118	82,52	25	17,48
August	140	116	82,86	24	17,14
September	141	117	82,98	25	17,73
October	140	116	82,86	24	17,14
November	143	118	82,52	25	17,48
December	148	122	82,43	26	17,57
In a year	1830	1518	82,95	315	17,21

Insemination with sexed sperm accounts for 82.95% and regular sperm - 17.21% of the total number of animals. Every month 24-30 heads of animals were inseminated with regular sperm, and 140-178 heads with sexed sperm. Cows and heifers were inseminated with the most sexed sperm in March (178).

In the reporting year, the farm calved 1,043 cows and 488 heifers, of which, respectively, 44.87% and 77.25% of animals that calved from insemination with sexed sperm (Table 4).

Table 4

Dynamics of monthly calving of broodstock

The month of the year	cows					heifers				
	total	Sexed sperm		Regular sperm		total	Sexed sperm		Regular sperm	
		го.л.	%	го.л.	%		го.л.	%	го.л.	%
January	107	15	14,02	92	85,98	16	13	81,25	3	18,75
February	100	7	7,00	93	93,00	34	18	52,94	16	47,06
March	63	3	4,76	60	95,24	45	27	60,00	18	40,00
April	73	12	16,44	61	83,56	15	4	26,67	11	73,33
May	96	7	7,29	89	92,71	39	27	69,23	12	30,77
June	67	8	11,94	59	88,06	34	24	70,59	10	29,41
July	90	60	66,67	30	33,33	24	22	91,67	2	8,33
August	79	66	83,54	13	16,46	33	21	63,64	12	36,36
September	98	77	78,57	21	21,43	29	26	89,66	3	10,34
October	85	67	78,82	18	21,18	57	51	89,47	6	10,53
November	90	71	78,89	19	21,11	79	70	88,61	9	11,39
December	95	75	78,95	20	21,05	83	74	89,16	9	10,84
In a year	1043	468	44,87	575	55,13	488	377	77,25	111	22,75

From January to June, less calves (4.76-16.44%) were obtained from cows with sexed semen, from July to December this figure was at the level of 66.67-83.54%.

Per 100 cows, 46 heifers were introduced into the herd and the monthly introduction was almost at the same level. From them due to insemination with sexed

sperm the least calves were obtained in April (15 heads, or 26.67%).

The yield of calves per 100 cows from sexed and regular semen was almost at the same level. Thus, from insemination with sexed sperm, this figure is 55.19%, normal - 44.81%. That is, 159 heads, or 10.38% more calves, were obtained from the mating of broodstock with sexed sperm (Table 5).

Table 5

Yield of calves per 100 cows

The month of the year	Yield					Heifers born	
	total	Sexed sperm		Regular sperm		number	%
		number	%	number	%		
January	123	28	22,76	95	77,24	71	57,72
February	134	25	18,66	109	81,34	75	55,97
March	108	30	27,78	78	72,22	64	59,26
April	88	16	18,18	72	81,82	49	55,68
May	135	34	25,19	101	74,81	79	58,52
June	101	32	31,68	69	68,32	61	60,40
July	114	82	71,93	32	28,07	87	76,32
August	112	87	77,68	25	22,32	88	78,57
September	127	103	81,10	24	18,90	102	80,31
October	142	118	83,10	24	16,90	114	80,28
November	169	141	83,43	28	16,57	136	80,47
December	178	149	83,71	29	16,29	144	80,90
In a year	1531	845	55,19	686	44,81	686	44,81

The highest rate of calves for insemination with sexed semen was obtained from July to December (71.93-83.71%), the lowest - from January to June (18.18-31.68%). The yield of calves from insemination with regular semen during the year was as follows: January-June - the highest (68.32-81.82%), July-December - the lowest (16.29-28.07%).

The most complete data on the use of sexed and normal sperm give research on the number of viable heifers.

The study of the effect of sexed sperm on the fertility of the broodstock leads to the conclusion that its use reduces the ability to fertilize animals by an average of 25.0% (Table 6).

Table 6

Reproductive indicators for the use of sperm

Indicator	regular sperm	sexed sperm
The yield of calves per 100 cows,%	90	75
Cow culling due to reproduction problems,%	15	15
Livestock of calves after culling per 100 cows,%	75	68
Livestock of heifers after culling per 100 cows, number	37	61
There are heifers left in the herd for 100 cows, number	33	58

The number of calves after culling per 100 cows with the use of sexed semen decreased by 7%, and normal - by 15%. The number of heifers left in the herd after culling for use for insemination of normal semen was almost 2 times less, and for sexed semen - only 7 heads, or 10.3%.

Heifers, which were mated with sexed semen, were left to be introduced into the herd with 58 heads per 100 cows, and normal heifers with 33 heads, which is 22% less.

The choice of a breeding bull for insemination of the broodstock population should take into account the exterior of the animal, live weight, productivity of its ancestors and its own productivity. No less important condition for achieving the best results is the fertilizing ability of the sperm of a breeding bull.

According to the results of research, the best birth rate of heifers was obtained from insemination of broodstock with sexed sperm of a breeding bull V.Kh. Cardinals [5] 3130854061 - 92.8% (Table 7).

Table 7

The results of the use of sexed semen depending on the breeding bull

Nickname of the breeding bull	Calves were born, total number	among		% heifers born	Dead born, number
		heifers	bulls		
S. Celebrat 68841724	241	153	88	63,5	15
V.H. Cardinals 3130854061	28	26	1	92,8	1
S. Bloomfield 3130920421	39	32	4	82,0	2
Total	308	211	93	68,5	18

The lowest indicator was found in the bull S. Kelibrat 68841724 (63.5%), which is 29.3% less than the indicators of V.Kh. Cardinals 3130854061. The sperm of this bull S. Kelibrat 68841724 inseminates the largest number of heads of breeding stock.

The birth rate of heifers from mating with the sperm of a breeding bull S. Bloomfield 3130920421 was 82%, but it is less than the highest rate of V.Kh. Cardinals 3130854061 by 10.8%.

The results of a single insemination with sexed sperm on the fertility of animals and the percentage of heifers in the offspring.

For example, from 50 fertilized with sexed sperm will be obtained 45 heifers, which is 20 heifers more than 50 inseminated with normal sperm. If the market value of one breeding heifer when grown to mating age (15-16 months) and live weight of 450 kg is equal to: 50400 UAH. (\$ 1800). The cost of 20 additionally received heifers is 1008 thousand UAH. (\$ 36). The cost of 20 bulls obtained from ordinary sperm grown on the farm up to 450 kg at a price of 44 UAH. / kg is equal to UAH 396,000. (\$ 14,142). The difference in the market value of 20 heifers and 20 bulls is: UAH 612,000. (\$ 21857).

The increase in the cost of sexed sperm compared to normal, to obtain 20 heifers will be: 75 000 UAH (\$ 2679). Therefore, the net profit from 20 additional heifers is equal to UAH 537,000. (\$ 19179).

Per one heifer additionally obtained from sexed semen, the net profit is 26850 UAH. (\$ 959).

Conclusions:

1. According to 2019, hopes for a cow amounted to 10,870 kg with a mass fraction of fat in milk 3.7% and protein at 3.3%.

2. In the farm when fertilizing heifers with sexed sperm sperm consumption is 1.3 doses per 1 heifer, and in normal - 1.1.

3. Insemination with sexed sperm accounts for 82.95% and normal - 17.21% of the total number of animals.

4. In the reporting year, the farm calved 1,043 cows and 488 heifers, of which 44.87% and 77.25% of animals, respectively, which were calved from insemination with sexed semen.

5. The yield of calves from insemination with sexed sperm is 55.19%, regular - 44.81%. 159, or 10.38% more calves, were obtained from broodstock with sexed semen.

6. The use of sexed semen reduces the ability to fertilize animals by an average of 25.0%.

7. The best birth rate of heifers was obtained from insemination of broodstock with sexed sperm of a breeding bull V.Kh. Cardinals 3130854061 - 92.8%.

8. For one hryvnia invested in the purchase of semen, divided by sex, the company receives a profit of 7.16 UAH, which proves of the high profitability of its use.

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№48, 2020
Slovak international scientific journal

VOL.1

The journal has a certificate of registration at the International Centre in Paris – ISSN 5782-5319.

The frequency of publication – 12 times per year.

Reception of articles in the journal – on the daily basis.

The output of journal is monthly scheduled.

Languages: all articles are published in the language of writing by the author.

The format of the journal is A4, coated paper, matte laminated cover.

Articles published in the journal have the status of international publication.

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