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## **INFLUENCE OF PARATYPIC FACTORS ON THE FERTILITY OF DAIRY COWS AND REPLACEMENT HEIFERS**

**Admina Natalia**, Candidate of Agricultural Sciences, Senior Researcher, S. S. R.,

<http://orcid.org/0000-0001-5224-2640>

**Admin Olexandr**, Candidate of Agricultural Sciences, S. S. R.,

<http://orcid.org/0000-0002-5070-8926>

**Osypenko Tetiana**, Candidate of Agricultural Sciences,

<https://orcid.org/0000-0002-2605-3587>,

**Livestock farming institute of NAAS, Kharkiv, Ukraine**

**Yemets Z. V.**, Candidate of Agricultural Sciences, Associate Professor,

<https://orcid.org/0009-0007-1507-9734>

**Odesa State Agrarian University, Ukraine**

*The results of researching the influence of the season, air temperature, age, stage of lactation, insemination number and daily milk yield on the fertilization of heifers and cows under different housing technologies are presented.*

*It was established that the best fertilization was demonstrated by heifers kept in tethered housing at PE Agroprogres. Nevertheless, the fertilization rate of cows among the farms under study was the highest under free housing ( $p < 0.001$ ).*

*By months of the year, in general, on all farms, a trend of a greater number of inseminations of heifers was observed in spring and summer, although no clear dependence was established. The share of fertile inseminations of heifers of PE Agroprogres varied from 56% in October to 92% in June. Fertilization of heifers at SE EFs named after Dekabrists and Kutuzivka had less variability: from 47% in February to 70% in May in the first farm and from 46% in May to 60% in July in the second farm, respectively. At PE Agroprogres and SE EF named after Dekabrists, there was a tendency to increase the fertilization of heifers at the air temperature above 20 °C. Cows of PE Agroprogres and SE EF named after Dekabrists had the lowest fertilization rate at temperatures below -10 °C. There was also a trend of its increase with an increase in air temperature above 20 °C.*

*It was established that at PE Agroprogres (tethered housing) a clear trend of increasing the fertility of cows was observed during the period of summer open air housing, at SE RF named after Dekabrists this trend is almost imperceptible, and the opposite dependence has been established at SE EF Kutuzivka (year-round free housing keeping with feeding on walking platforms).*

*At all studied farms, there was a clear tendency in decrease of the fertilization of cows during the period of high milk productivity. Cows of PE Agroprogres and SE EF Kutuzivka with a daily milk yield of more than 40 kg of milk were fertilized worse by 1-4% ( $p < 0.1$ ) and 5-6% ( $p < 0.001$ ) than animals with a lower milk yield. Cows of the SE EF named after Dekabrists with a daily milk yield of more than 30 kg also had 8-9% ( $p < 0.001$ ) worse fertilization compared to animals with lower productivity. At all studied farms, the highest percentage of fertilization was characterized by heifers at their first insemination, and among cows were animals of the first and second calving. According to all inseminations, the average day of lactation of cows with their artificial insemination was 38-54 days longer at SE EF named after Dekabrists in comparison with PE Agroprogres and SE EF Kutuzivka ( $p < 0.001$ ). The share of fertilized cows during the breeding period up to 90 days after calving was lower by 6% At PE*



Agroprogres, and by 9% at SE EF named after Dekabrists, and by 6% at SE EF Kutuzivka than in the mid-lactation period (91-180 days) ( $p < 0.001$ ).

**Key words:** paratypic factors, dairy cattle, fertilization, housing technology, season, air temperature, daily yield.

## ВПЛИВ ПАРАТИПОВИХ ЧИННИКІВ НА ЗАПЛІДНЮВАНІСТЬ МОЛОЧНИХ КОРІВ ТА РЕМОНТНИХ ТЕЛИЦЬ

Адміна Н. Г., к. с.-г. н., ст. дослідник, с. н. с.,

<http://orcid.org/0000-0001-5224-2640>

Адмін О. Є., к. с.-г. н., с. н. с., <http://orcid.org/0000-0002-5070-8926>

Осипенко Т. Л., к. с.-г. н., <https://orcid.org/0000-0002-2605-3587>,

Інститут тваринництва НААН, Харків, Україна

Ємець З. В., к. с.-г. н., доцент, <https://orcid.org/0009-0007-1507-9734>

Одеський державний аграрний університет

*Викладено результати досліджень впливу сезону року, температури повітря, віку, стадії лактації, номеру осіменіння та добового надою на запліднюваність телиць та корів за різних технологій утримання.*

*Встановлено, що найкращою запліднюваністю характеризувались телиці за прив'язного утримання у ПП «Агропрогрес». У той же час запліднюваність корів серед досліджуваних господарств була найвищою за безприв'язного утримання ( $p < 0,001$ ).*

*За місяцями року в цілому по всіх господарствах спостерігалась тенденція більшої кількості осіменінь телиць навесні та влітку, хоча чіткої залежності не встановлено. Частка плідних осіменінь телиць ПП «Агропрогрес» змінювалась від 56 % у жовтні до 92 % у червні. Запліднюваність телиць у ДП ДГ ім. Декабристів та «Кутузівка» мала меншу варіабельність: від 47 % у лютому до 70 % у травні у першому господарстві та від 46 % у травні до 60 % у липні в другому господарстві, відповідно. У ПП «Агропрогрес» та ДП ДГ ім. Декабристів спостерігалась тенденція збільшення запліднюваності телиць за температури повітря вище +20 °С. Найнижчою запліднюваністю характеризувались корови ПП «Агропрогрес» та ДП ДГ ім. Декабристів за температури нижче -10 °С. Також спостерігалась тенденція її збільшення із підвищенням температури повітря вище 20 °С.*

*Встановлено, що у ПП «Агропрогрес» (прив'язне утримання) спостерігалась чітка тенденція збільшення запліднюваності корів у період літньо-табірного утримання, у ДП ДГ ім. Декабристів ця тенденція майже непомітна, а у ДП ДГ «Кутузівка» (цілорічне безприв'язне утримання з годівлею на вигульних майданчиках) встановлено протилежну залежність.*

*У всіх досліджуваних господарствах спостерігалась чітка тенденція зниження запліднюваності корів у період високої молочної продуктивності. Корови ПП "Агропрогрес" та ДП ДГ "Кутузівка" із добовим надоєм вище 40 кг молока запліднювались гірше на 1-4 % ( $p < 0,1$ ) та 5-6 % ( $p < 0,001$ ) ніж тварини з нижчим надоєм. Корови ДП ДГ ім. Декабристів із добовим надоєм вище 30 кг також мали на 8-9 % ( $p < 0,001$ ) гіршу запліднюваність у порівнянні з тваринами з нижчою продуктивністю. У всіх досліджуваних господарствах найбільшим відсотком запліднюваності характеризувались телиці при їх першому осіменінні, а серед корів – тварини першого та другого отелення. За всіма осіменіннями сере-*



дній день лактації корів при їх штучному осіменінні був більшим на 38-54 діб у ДП ДГ ім. Декабристів у порівнянні з ПП «Агропрогрес» та ДП ДГ «Кутузівка» ( $p < 0,001$ ). Частка запліднених корів у період роздою до 90 днів після отелення була нижчою на 6 % у ПП «Агропрогрес», на 9 % у ДП ДГ ім. Декабристів та на 6 % у ДП ДГ «Кутузівка» ніж у період середини лактації (91-180 діб) ( $p < 0,001$ ).

**Ключові слова:** паратипові фактори, молочна худоба, запліднюваність, технологія утримання, сезон року, температури повітря, добовий надій.

Reproduction of cattle is one of those problems, which becomes more and more relevant as livestock farming becomes more specialized and concentrated. Furthermore, the efficiency of dairy farming directly depends on the fertility of cows as the most specific indicator of profitability, which is closely related to the duration of the use of animals in farms (Vedmedenko O. V., 2018.). It is known that the good reproductive capacity of animals contributes to a more complete realization of their genetic potential (Krip O. M., 2012). Low reproduction rates restrain the pace of renewal of the herd and thereby reduce the possibility of selection for the main selection characteristics.

At dairy farms, climatic conditions should be taken into account when choosing a strategy for breeding and impregnating cows (Schüller L. K. et al., 2016.). Excessive temperature and humidity of the environment can impair productivity and fertilization of dairy cows (Nguyen T. T. T. et al., 2016; Cartwright S.L. et al., 2023; Polsky L. and Marina A. G. von Keyserlingk, 2017). Research has established that cows that have experienced heat stress have low fertility, which leads to a decrease in the level of fertilization in the herd as well as its frequency by 20-30 % (De Rensis F. et al., 2017). Summer heat stress is the main cause of low fertilization in dairy cattle (Wolfenson D. and Roth Z., 2019). For dairy cows, the ambient temperature from  $-5\text{ }^{\circ}\text{C}$  to  $25\text{ }^{\circ}\text{C}$  is known as the thermoneutral zone (De Rensis F. et al., 2015). Australian scientists found that heat resistance has a favorable genetic correlation with fertility (0.29–0.39 in Holsteins and 0.15–0.27 in Jerseys), but unfavorable correlations for some other productive traits (Nguyen T. T. T. et al., 2016). Heat stress is an essential component of low fertility in dairy cattle. First- and second-lactation cows are adversely affected by heat before and after the day of insemination, even if their sensitivity is not the same. (Biffani S. et al., 2016). The results of another study indicate that heat stress on the day of estrus significantly reduces the intensity of its external signs, and the size of the follicle decreases with increasing temperature and air humidity (Schüller L. K. et al., 2017). Heat stress is the main environmental factor responsible for low reproductive performance in cattle, especially during the summer season in many warm regions of the world. This worldwide problem causes significant economic losses and affects about 60% of the world's cattle population. (Schüller L.K. et al., 2014).

Cows that were conceived in winter were found to have better subsequent reproduction, milk and fat production and survival compared to cows that were conceived in summer. These results proved that heat stress during conception can change epigenetic processes that can affect the early embryo (Pinedo P. J. and De Vries A., 2017.).

There is an antagonistic relationship between fertility and milk yield, and intensive selection for milk yield greatly impairs reproductive efficiency (Sammad A. et al., 2020). Some researchers point to the negative impact of high productivity of cows on their reproductive function, which is evidenced by prolongation of the terms of uterine involution during the manifestation of the first need, a high indicator of the service period and a low yield of calves. (Chen J. et al., 2015). Ukrainian scientists also note the deterioration of the reproductive capacity of cows with an increase in their milk



productivity (Skoromna O. I. et al., 2020). This appears to be in the increased duration of the service period, the intercalving period and the insemination index, which negatively affects the economic efficiency of dairy farming (Vatskyi V. F. and Velychko S. A., 2012). Researches of other scientists have also established that there is only a positive correlation from +0.04 to +0.25 between the fat content and the main characteristics of the reproductive capacity of cows of various development types. (Hyl M. et al., 2018). The results of research of some scientists on the study of potential fertility depending on the amount of milk yield of cows (from 5 to 13 thousand kg of milk) showed that milk productivity does not affect the development of dominant follicles, ovulation and the formation of corpora lutea. Fertilization of oocytes and survival of embryos was at the same level without statistical difference and was 81–84% and 73–76%, respectively (Chen J. et al., 2016.).

Fertilization of heifers at an early age ensures better development of reproductive organs and udder, higher payment for feed and practically does not affect the development of the fetus and the amount of body weight of offspring (Sharapa H. S. and Boiko O. V., 2017). Scientists, while studying the influence of the age of heifers of Holstein, Ukrainian black-and-white and red-and-white dairy breeds at fertile insemination on indicators of reproductive capacity and milk productivity in the first two lactations, found that the optimal age of insemination of heifers should be considered as 14-18 months. with their normal individual development and body weight of 360–380 kg (Sharapa H. S. et al., 2021). In other studies, it was found that in most heifers, which became fertile after 17 months old and in all heifers inseminated at the age of 20 months and older, fertilization occurred after several inseminations, which indicates a violation of the reproductive function in these animals (Kraievskiy A. Y. et al., 2020).

Therefore, in order to achieve optimal results of fertilization of heifers and cows in farms, it is necessary to take into account paratypic factors that affect the reproduction process of animals.

In this regard, the aim of the work is to determine the fertilization of dairy cows and replacement heifers depending on paratypic factors.

**Research materials and methods.** The work was carried out at SE EF Kutuzivka and PE Agroprogres of the Kharkiv oblast and SE EF named after Dekabrists of the Poltava oblast according to zootechnical records in the period 2015-2021. The first two enterprises are breeding plants for the breeding of the Ukrainian black-and-white dairy breed, the third is the Ayrshire breed. The yield per cow in the specified period amounted to more than 6,000 kg of milk. In total, the results of 6,878 inseminations of heifers and 25,634 cows were analyzed.

At the dairy complex SE EF Kutuzivka, the animals are kept untethered on permanent straw bedding. At the farm of PE Agroprogres, there is tethered housing, and at SE EF named after Dekabrists both technologies of retention are used.

Fertilization was defined as the ratio of the number of fertile inseminations to their total number. The data of daily milk yield, which was obtained up to 9 days from the date of insemination, were used in the study.

The influence of the following paratypic factors on the fertilization of heifers and cows was determined: season, air temperature, age, lactation stage, insemination number, daily milk yield and milk production technology. According to these factors, data on the results of artificial insemination were assigned to the appropriate groups. The exact characteristics of the groups are given. Processing of the obtained data was carried out according to basic statistical techniques using computer programs.



**Research results.** It was established that the best fertilization of heifers was found under tethered housing at PE Agroprogres. It was 1.3 times higher in comparison with SE EF named after Dekabrists and 1.4 times exceeded the fertilization rate of heifers at SE EF Kutuzivka (Table 1).

Furthermore, the fertilization rate of cows among the farms under study was the highest under free housing. The share of fertile inseminations of cows at RF Kutuzivka was 7% higher in comparison with the SE EF named after Dekabrists and 9% higher than in cows of PE Agroprogres. Differences according to this indicator were highly probable for both heifers and cows ( $p < 0.001$ ).

The higher fertilization rate of cows at SE EF Kutuzivka is explained by the use of an automatic system for determining sexual desire of animals at the dairy complex, which allows more precisely determining the time of insemination of cows.

Table 1

**Average fertilization of heifers and cows**

Enterprise	Heifers		Cows	
	number of inseminations	share of fertile inseminations, %	number of inseminations	share of fertile inseminations, %
PE Agroprogres	1256	75±0.5	9699	28±0.2
SE EF named after Dekabrists	1608	57±0.6	5813	30±0.3
SE EF Kutuzivka	4014	54±0.4	10122	37±0.2
Total	6878	59±0.4	25634	32±0.1

Next, the distribution of the number of inseminations of heifers (Fig. 1) and their fertilization rate (Fig. 2) by month of the year was considered.

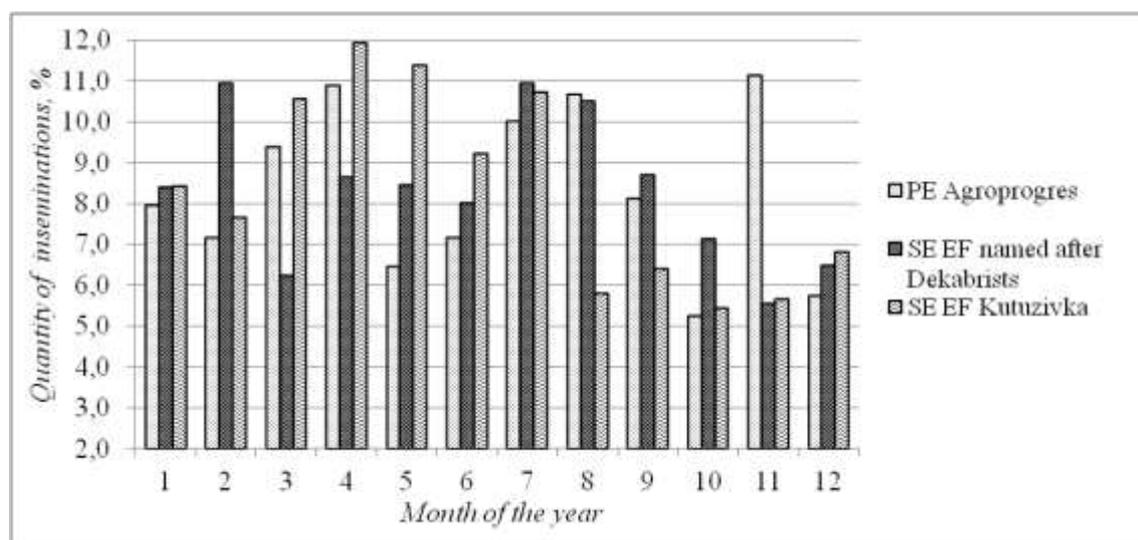


Fig. 1. Distribution of heifer insemination by months of the year, %

The largest number of inseminations of heifers at PE Agroprogres was carried out in April (10.9%) and November (11.1%), and the smallest – in October (5.3%). On



the SE EF named after Dekabrists, the largest number of inseminations (10.4%) was recorded in February and July, and in November the share of inseminations was only 5.5%. Heifers were more often inseminated in April (11.9%) and May (11.4%), while in October the share of inseminations decreased to 5.4%. If we take all farms as a whole, the trend of more inseminations in spring and summer was observed. However, a clear dependence has not been established, which may be related to the seasonality of calvings and the peculiarities of growing replacement heifers.

A more important indicator that characterizes reproduction is the fertilization of heifers (Fig. 2).

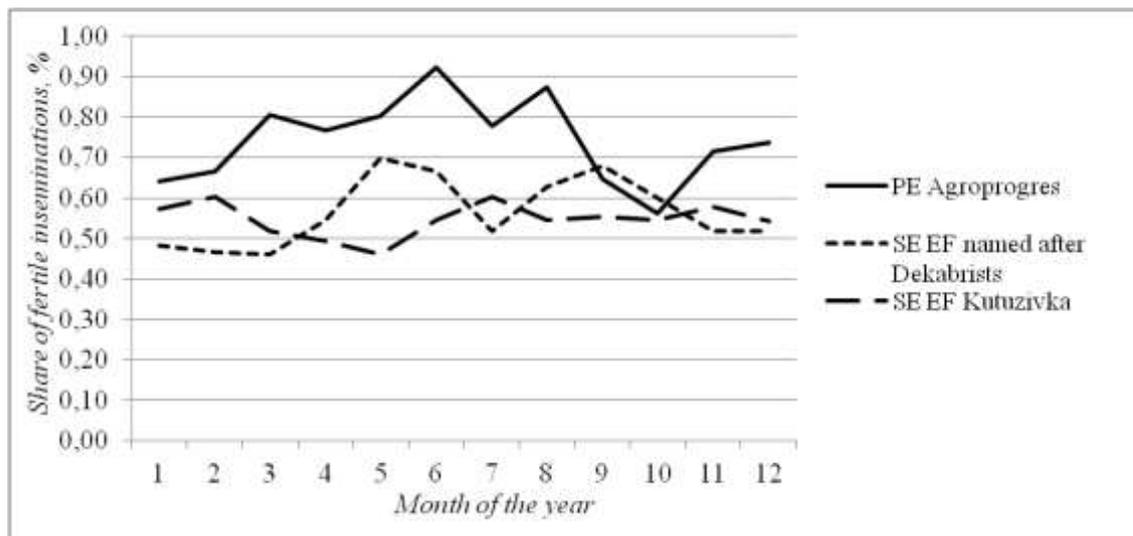


Fig. 2. Fertilization of heifers by month of the year

The evaluation of the effects between group factors using variance analysis showed a probable influence ( $p < 0.001$ ) on the fertilization of heifers of the following factors: "household" 2.2%, "month of the year" 0.6% and their combined influence 1.5%. The share of fertile inseminations of heifers of the PE Agroprogres varied from  $56 \pm 6.2\%$  in October to  $92 \pm 2.8\%$  in June. Fertilization of heifers in the SE EF named after Dekabrists and SE EF Kutuzivka had less variability: from  $47 \pm 3.8\%$  in February to  $70 \pm 3.9\%$  in May in the first farm and from  $46 \pm 2.3\%$  in May to  $60 \pm 2.4\%$  in July in the second one, respectively. The obtained data indicate that the same dependence of the fertilization of heifers on the month of the year has not been established. The greatest variability of this indicator is inherent in PE Agroproges, and the smallest one is in SE EF Kutuzivka.

The "air temperature" factor is related to the month of the year and more precisely indicates the state of the environment during insemination. In this regard, the influence of environmental temperature on the fertilization of heifers was studied (Table 2).

The results of the variance analysis show that the influence of the "household" factor on the fertilization of heifers was 0.7%, "air temperature" factor was 0.5%, and the combined effect of these factors was 0.7% ( $p < 0.001$ ).



Table 2

**Fertilization of heifers at different air temperatures**

Air temperature, °C	PE Agroprogres		SE EF named after Dekabrists		SE EF Kutuzivka	
	number of inseminations	share of fertile inseminations, %	number of inseminations	share of fertile inseminations, %	number of inseminations	share of fertile inseminations, %
< -10	15	80±4.1	7	57±9.3	55	53±3.4
-10 – -1	116	54±2.3	185	55±1.8	477	60±1.1
0 – +9	334	72±1.1	403	51±1.2	1003	56±0.8
+10 – +19	385	76±0.9	393	55±1.2	916	49±0.8
+20 – +29	279	84±0.8	462	60±1.1	1275	55±0.7
> +29	127	82±1.3	152	68±1.8	266	56±1.5

Differences between minimum and maximum fertilization rates were likely. Thus, in PE Agroprogres they made up 30%, in SE EF named after Dekabrists – 17%, and 11% SE EF Kutuzivka – 11%. It should be noted that in the first two farms there was a tendency to increase the fertilization rate of heifers at air temperatures above +20 °C. A similar trend was not detected in the experimental farm Kutuzivka.

Then, we consider how the fertilization of heifers changes depending on the serial number of insemination (Table 3).

Table 3

**Fertilization of heifers depending on the serial number of insemination**

Insemination number	PE Agroprogres		SE EF named after Dekabrists		SE EF Kutuzivka	
	number of inseminations	share of fertile inseminations, %	number of inseminations	share of fertile inseminations, %	number of inseminations	share of fertile inseminations, %
1	987	79±0.5	921	59±0.8	2369	58±0.5
2	177	61±1.8	396	58±1.2	918	53±0.8
3	64	61±3.0	155	48±2.0	399	47±1.2
4	22	64±4.9	75	48±2.9	174	45±1.9
5	5	60±10.7	37	54±4.1	74	23±2.1
6	-	-	13	54±6.9	39	46±4.0
7	-	-	5	20±7.2	19	16±3.1

As it is shown in the table, in all studied farms, the highest percentage of fertilization of heifers was observed at their first insemination. It was higher by 15-19% in the animals of PE Agroprogres, by 1-29% in SE EF named after Dekabrists, and by 5-42% in SE EF Kutuzivka in comparison with subsequent inseminations. The influence of the "household" factor on the fertilization of heifers was 0.1% (p<0.05), the "insemination number" factor was 0.8% (p<0.001), and the combined effect of these



factors was 0.3% ( $p < 0.05$ ). This indicates that an increase in the insemination number reduces the probability of animal fertilization.

Next, the influence of paratypic factors on the fertilization of cows was considered. The distribution of the number of inseminations of cows by month of the year is shown in Figure 3.

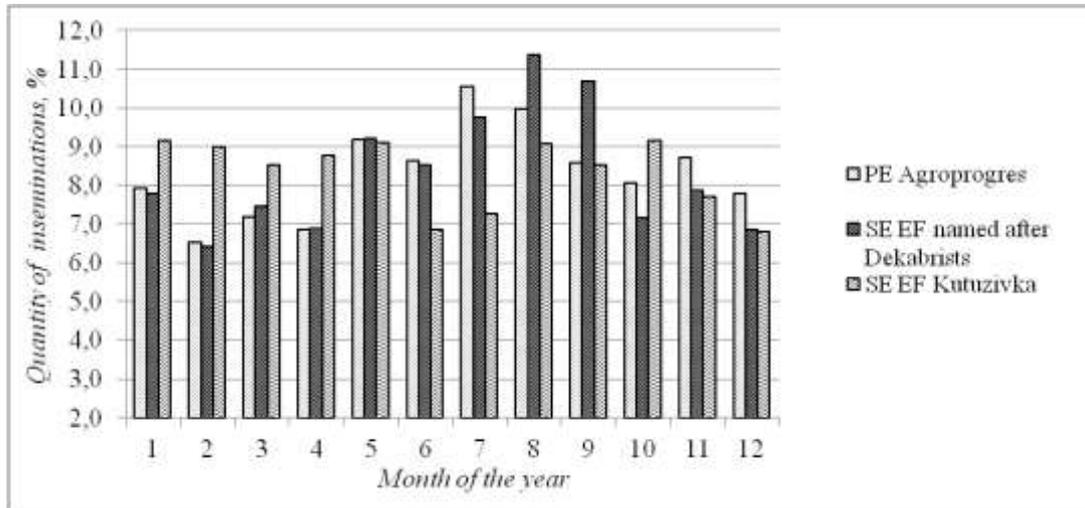


Fig. 3. Distribution of insemination of cows by months of the year, %

The largest number of inseminations of cows in PE Agroprogres was carried out in July (10.5%) and August (10.0%), and the smallest one was in February (6.5%). In SE EF named after Dekabrists, a greater number of inseminations (10.4%) was carried out in August (11.4%), and in February the share of inseminations was only 6.4%. Heifers were more often inseminated in January and October (9.2%), and in June, the share of inseminations decreased to 6.9% in SE EF Kutuzivka. In the first two farms, a tendency to increase the number of inseminations of cows in the summer was observed, but no clear dependence was established. In SE EF Kutuzivka such a tendency was not observed at all.

Fertilization of cows by months of the year in the studied farms is shown in Figure 4.

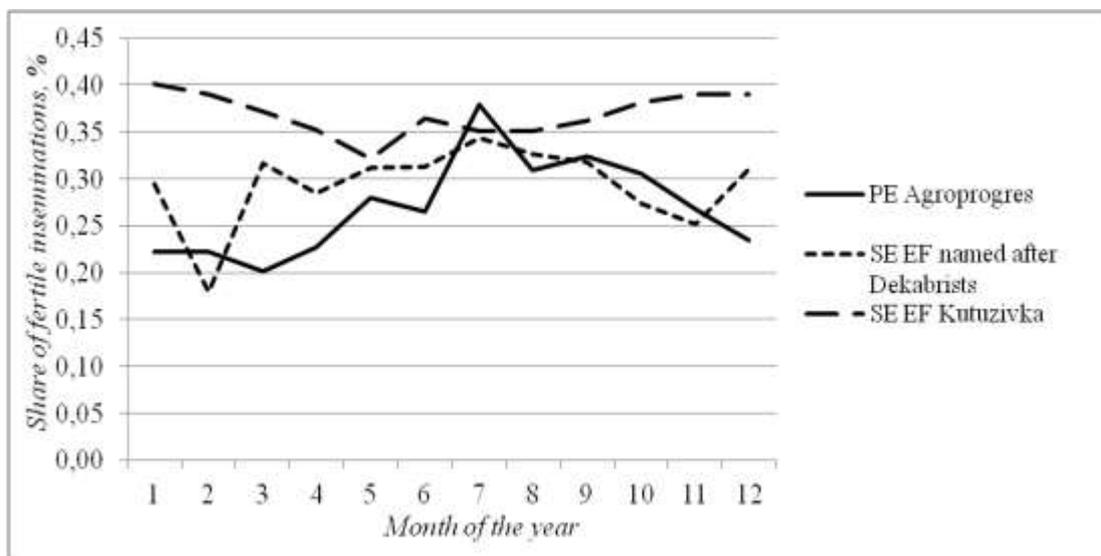


Fig. 4. Fertilization of cows by months of the year



The influence of the "household" factor on cow fertilization was 0.9%, the "month of the year" factor was 0.2%, and the combined effect of these factors was 0.5% ( $p < 0.001$ ). The share of fertile inseminations of cows of PE Agroprogres varied from  $20 \pm 0.6\%$  in March to  $38 \pm 0.7\%$  in July, SE EF named after Dekabrists – from  $18 \pm 0.8\%$  in February to  $34 \pm 0.9\%$  in July, SE EF Kutuzivka – from  $32 \pm 0.7\%$  in May to  $40 \pm 0.7\%$  in January. The differences between the minimum and maximum values of fertilization of cows were significant ( $p < 0.001$ ) and were 18%, 16% and 8%, respectively. They indicate greater variability of fertilization in the first farm and the smallest in the third. Thus, according to the graphs, it should be noted that in the first farm (tethered housing) there was a clear tendency to increase the fertilization of cows during the period of summer camp housing, in the second farm this trend is almost imperceptible, and in the third (year-round free housing with feeding on pastures) becomes the opposite.

The results of the study of the influence of environmental temperature on the fertilization of cows are shown in Table 4.

Differences between the minimum and maximum rates of fertilization at different air temperatures were likely in PE Agroprogres – 16%, in SE EF named after Dekabrists – 13%. At the same time, these differences in SE EF Kutuzivka were only 2% and were improbable. It should be noted that in the first two farms, cows were characterized by the lowest fertilization at the temperature below  $-10\text{ }^{\circ}\text{C}$ , and a trend of its increase with an increase in air temperature above  $20\text{ }^{\circ}\text{C}$  was observed. A similar trend has not been established in SE EF Kutuzivka. The influence of the "household" factor on cow fertilization was 0.4%, the "air temperature" factor was 0.1%, and the combined effect of these factors was 0.3% ( $p < 0.001$ ).

*Table 4*

**Fertilization of cows at different air temperatures**

Air temperature, $^{\circ}\text{C}$	PE Agroprogres		SE EF named after Dekabrists		SE EF Kutuzivka	
	number of inseminations	share of fertile inseminations, %	number of inseminations	share of fertile inseminations, %	number of inseminations	share of fertile inseminations, %
< -10	96	$16 \pm 1.3$	57	$25 \pm 2.5$	110	$37 \pm 2.2$
-10 – -1	1205	$23 \pm 0.5$	663	$27 \pm 0.8$	1367	$39 \pm 0.6$
0 – +9	2373	$24 \pm 0.4$	1284	$28 \pm 0.6$	2814	$39 \pm 0.4$
+10 – +19	2356	$29 \pm 0.4$	1518	$28 \pm 0.51$	2302	$36 \pm 0.5$
+20 – +29	2752	$32 \pm 0.4$	1811	$32 \pm 0.5$	2765	$35 \pm 0.4$
> +29	914	$29 \pm 0.7$	476	$36 \pm 1.0$	737	$37 \pm 0.9$

It was also considered how the fertilization of cows changes depending on the serial number of insemination (Table 5).

During the first insemination after calving, a lower percentage of cow fertilization was observed in all studied farms. During the second insemination, it increased by 4% in the animals of PE Agroprogres, by 5% in SE EF named after Dekabrists and by 4% in SE EF Kutuzivka ( $p < 0.001$ ). Further growth in the number of insemination cows in the first two farms did not lead to probable changes in fertilization. At the same time, the cows of SE EF Kutuzivka, starting from the 6th insemination, were probably fertilized worse (by 13-20% less than from the second insemination). The influence of the factor "household" on the fertilization of cows was



unlikely, the factor "insemination number" was 0.2% ( $p < 0.001$ ), and the combined effect of these factors was 0.2% ( $p < 0.001$ ).

Table 5

**Fertilization of cows depending on the serial number of insemination**

Insemination number	PE Agroprogres		SE EF named after Dekabrists		SE EF Kutuzivka	
	number of inseminations	share of fertile inseminations, %	number of inseminations	share of fertile inseminations, %	number of inseminations	share of fertile inseminations, %
1	3130	25±0.3	2105	27±0.4	4498	36±0.3
2	2286	29±0.4	1497	32±0.6	2539	40±0.5
3	1552	29±0.5	917	33±0.7	1369	40±0.6
4	1008	30±0.7	542	30±0.9	736	36±0.9
5	639	28±0.8	337	28±1.1	411	36±1.1
6	410	30±1.0	195	29±1.5	235	27±1.3
7	249	32±1.4	108	31±2.0	130	26±1.7
8	152	28±1.6	53	34±3.1	75	20±1.8
9	93	31±2.2	25	16±2.7	40	25±3.0
10	62	29±2.6	17	29±5.0	25	16±2.7

The lactation period was determined for each serial number of insemination of cows in the studied farms (Table 6).

Table 6

**The average day of lactation of cows depending on the serial number of insemination**

Insemination number	PE Agroprogres	SE EF named after Dekabrists	SE EF Kutuzivka
1	81±0.7	118±1.7	89±0.9
2	123±1.0	168±2.3	125±1.3
3	161±1.5	217±3.4	161±2.0
4	195±2.1	254±4.7	196±3.1
5	230±3.0	284±6.0	224±4.2
6	253±3.5	313±8.2	253±6.2
7	277±4.9	349±12.1	276±9.0
8	301±6.5	350±17.7	282±9.4
9	342±10.2	377±28.4	319±14.4
10	360±12.7	373±19.0	362±23.2
On average	146±0.9	184±1.5	130±0.9

The average day after calving at the first insemination in SE EF named after Dekabrists was probably longer by 29-37 days compared to the other two farms



( $p < 0.001$ ). This is possibly caused by missing the first sexual urges after calving, and possibly by postpartum complications. As a result, for all inseminations, the average day of lactation of cows with artificial insemination was 38-54 days longer in this farm than in PE Agroprogres and SE EF Kutuzivka ( $p < 0.001$ ).

The insemination number is related to the lactation period. Therefore, the next stage of the study was the determination of the fertilization of cows depending on the stage of lactation (Table 7).

Table 7

**Fertilization of cows at different stages of lactation**

Day after calving	PE Agroprogres		SE EF named after Dekabrists		SE EF Kutuzivka	
	number of inseminations	share of fertile inseminations, %	number of inseminations	share of fertile inseminations, %	number of inseminations	share of fertile inseminations, %
< 91	2921	23±0.3	1274	22±0.5	3958	34±0.4
91-180	4001	29±0.3	2095	31±0.5	3963	40±0.4
181-270	1789	30±0.5	1260	31±0.6	1441	37±0.6
> 270	984	31±0.7	1177	35±0.7	730	36±0.8

In the lactation period up to 90 days after calving, cows of all farms had the lowest percentage of fertilization. The share of fertilized cows in this period was lower by 6% in PE Agroprogres, by 9% in SE EF named after Dekabrists and by 6% in SE EF Kutuzivka than in the mid-lactation period (91-180 days) ( $p < 0.001$ ). In subsequent periods of lactation, the fertility of cows did not change significantly. The influence of the factor "household" on the fertilization of cows was 0.5%, the factor "stage of lactation" was 0.4%, and the combined effect of these factors was 0.1% ( $p < 0.001$ ). It is important to note that the average daily milk yield in the first period of lactation was probably higher compared to the following stages of lactation. Thus, in the cows of PE Agroprogres, it was equal to 26.7±0.16 kg, in SE EF named after Dekabrists – 26.5±0.19 kg and in SE EF Kutuzivka – 25.4±0.18 kg, which is by 2.5-8.3 kg, 1.4-6.9 kg and 1, 8-6.4 kg more, respectively, than in subsequent periods of lactation.

Table 8 shows data on the fertilization of cows with different daily milk productivity.

Table 8

**Fertilization of cows depending on daily milk yield**

Daily milk yeild, kg	PE Agroprogres		SE EF named after Dekabrists		SE EF Kutuzivka	
	number of inseminations	share of fertile inseminations, %	number of inseminations	share of fertile inseminations, %	number of inseminations	share of fertile insemination s, %
>40	66	26±2.4	-	-	188	32±1.6
40-29.9	821	27±0.7	189	25±1.4	1277	37±0.7
30-20	3222	27±0.3	1798	33±0.5	2853	38±0.4
<20	1798	30±0.5	538	34±1.0	2134	38±0.5



In all studied farms, there was a clear tendency to decrease the fertilization of cows during the period of high milk productivity. Cows of PE Agroprogres and SE EF Kutuzivka with a daily milk yield of more than 40 kg of milk were fertilized worse by 1-4% ( $p < 0.1$ ) and 5-6% ( $p < 0.001$ ) than animals with a lower milk yield. Cows of SE EF named after Dekabrists with a daily milk yield of more than 30 kg also had 8-9% ( $p < 0.001$ ) worse fertilization compared to animals with lower productivity.

Next, we will consider the influence of the age of cows at calving on their fertilization (Table 9).

Table 9

**Fertilization of cows of different ages**

Lactation number	PE Agroprogres		SE EF named after Dekabrists		SE EF Kutuzivka	
	number of inseminations	share of fertile inseminations, %	number of inseminations	share of fertile inseminations, %	number of inseminations	share of fertile inseminations, %
1	3248	28±0.4	2088	32±0.5	3829	39±0.4
2	2850	28±0.4	1417	30±0.6	2438	37±0.5
3	1787	27±0.5	979	29±0.7	1636	36±0.6
4	1084	27±0.6	585	29±0.9	1044	34±0.7
5	461	27±0.9	359	26±1.0	590	33±0.9
6	190	24±1.3	226	25±1.2	293	32±1.3
7	62	26±2.4	93	25±1.9	127	32±1.9

Firstborns and cows of the second calving were characterized by a somewhat higher relative share of fertile inseminations. Thus, the greatest number of fertile inseminations of these cows in PE Agroprogres was 1-4% higher than in older animals. In SE EF named after Dekabrists and SE EF Kutuzivka heifers were fertilized better by 1-7%. The influence of age on the fertilization of cows was 0.1% ( $p < 0.001$ ). Thus, the likely influence of the "household" factor and the combined influence of the "household" and "age" factors were not established, which indicates the same effect of the "age" factor in all studied farms.

**Discussion.** According to our data, it was established that the best fertilization was characterized by heifers in tethered housing at PE Agroprogres. It was 1.4 times higher than the insemination of heifers at SE EF Kutuzivka, where animals were in free housing. Therefore time, the fertilization rate of cows in the researched farms was the highest in free housing. The share of fertile inseminations of cows in SE EF Kutuzivka was 7% higher than in SE EF named after Dekabrists, and by 9% better fertilization of cows in PE Agroprogres. Other scientists have confirmed the significant impact of the housing system on the fertilization of cows. A stronger relationship between milk production and fertilization of cows was found in tethered housing compared to free housing (Sawa A. and Bogucki M., 2011). Summer heat stress is the main cause of low fertilization in dairy cattle (Wolfenson D. and Roth Z., 2019). Lactating dairy cows prefer an ambient temperature of -5 °C to 25 °C, which is known as the thermoneutral zone (De Rensis F. et al., 2015). It should be noted that at PE Agroprogres and SE EF named after Dekabrists, the lowest fertilization of cows was at a temperature below -10 °C, and there was a tendency to increase it with an increase in air temperature above 20 °C. According to our data, a clear tendency to increase the fertilization rate of cows during the period of summer camp keeping was observed in PE Agroprogres (tethered



housing), in SE EF named after Dekabrists, this trend is almost imperceptible, and in SE EF Kutuzivka (year-round free housing with feeding on pastures) it becomes the opposite. As for the dynamics of the fertilization of cows depending on their productivity, it should be noted that in all farms studied by us, a clear tendency to decrease the fertilization of cows was observed in the period of high milk productivity. Animals of PE Agroprogres and SE EF Kutuzivka with a daily milk yield of more than 40 kg of milk were fertilized worse by 1-4% ( $p < 0.1$ ) and 5-6% ( $p < 0.001$ ) than animals with a lower milk yield. Cows of SE EF named after Dekabrists cows with a daily milk yield of more than 30 kg also had 8-9% ( $p < 0.001$ ) worse fertilization compared to animals with lower productivity. Other researchers also point to this pattern (Chen J. et al., 2015; Dovolou E. et al., 2023; Skoromna O. I. et al., 2020; Vatskyi V. F. and Velychko S. A., 2012).

### **Conclusions:**

1. It was established that the nature and strength of the influence of the season of the year, air temperature, age, stage of lactation, number of insemination and daily milk yield on the fertilization of replacement heifers and cows depends on the technology of their housing.

2. It was found that the best fertilization was characterized by heifers under tethered housing in PE Agroprogres, and the fertilization of cows was the highest under free housing in SE EF Kutuzivka.

3. It was outlined that in PE Agroprogres and in SE EF named after Dekabrists observed a tendency to increase the fertilization of heifers at air temperature above +20 °C, and the lowest fertilization was characterized by cows in PE Agroprogres and SE EF named after Dekabrists at temperatures below -10 °C and a trend of its increase with an increase in air temperature above 20 °C was observed.

4. In all studied farms, heifers at their first insemination were characterized by the highest percentage of fertilization, and among cows – animals of the first and second calving.

5. It was established that in all studied farms there was a clear tendency to decrease the fertilization of cows during the period of high milk productivity.

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