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Organisation of dairy cattle herd reproduction

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A fairly high hereditary potential of cows of modern Ukrainian breeds in terms of the main traits of milk production is discussed. It was found that higher milk yield, content and amount of fat in milk are inherent in cows of the Ukrainian Black Speckled Dairy breed, which in the context of the four evaluated lactations were better, except for the third (where no clear leader was found for the main traits). In modern high-yielding herds of Ukrainian cattle, the duration of lactation, regardless of the genotype with or without Holstein bloodlines, exceeds the optimal value (305 days), which is associated with later insemination of cows after calving and an extended service period. Therefore, when assessing the efficiency of dairy cows, it is advisable to take into account the number of milk days and adjust their milk production and reproductive capacity accordingly. And the effect of Holsteinisation on the lengthening of the lactation period occurs only in the herd of the Ukrainian Black Speckled Dairy breed. The milk yield reflex of the cows of the studied breeds is within the limits of the accepted optimal indicators, which indicates their good adaptability and adaptation to the technology of machine milking, and the live weight of animals of the three studied breeds at the end of the growing period is within the breed standards. However, it is higher in the Red and Black Speckled Dairy breeds, which indicates their better ability to high growth intensity under appropriate growing conditions and, as previous studies have shown, to better milk production. The degree of development of the main body structure measurements of cows is within the standards and corresponds to the norms of the dairy cow type, and no clear advantage in favour of a certain group of cows was found for the main measurements. The height at the withers, depth and width of the chest are better developed in Ukrainian Black Speckled Dairy cattle, and the oblique length of the body and the girth of the metacarpal — in the Ukrainian Red Dairy breed, with a larger girth of the chest in the Ukrainian Red Speckled Dairy breed. The analysis of the reproductive function of cows gives grounds to assert that among all the studied breeds there is a significant deterioration, which leads, regardless of breed affiliation, to an increase in the duration of service period (128–132 days) and the period between calvings (406–423 days), and this negatively affects the calf yield per year and, as a result, significantly increases the insemination index (6.40–6.59). The analysis of correlations between the main selection traits of mothers and their daughters established high predictions for their inheritance (0.48–1.06), which will significantly increase the efficiency of selection for milk yield and milk fat in these herds of modern breeds.

Key words: reproductive function, sexual desire, service period, insemination index, dry period, artificial insemination, milk production, breed

Introduction

The intensification of dairy farming is inextricably linked to the mechanisation and automation of labour-intensive processes, the creation of a solid feed base, the acquisition of highly productive cattle, and the use of technology that takes into account the biological characteristics of animals. In this regard, there is a need to evaluate and select animals [27]. Studying the productive, technological and reproductive characteristics of animals of the Ukrainian Black Speckled Dairy, Ukrainian Red Speckled Dairy and Ukrainian Red Dairy breeds of the country for the purpose of its further improvement and rational use is of great scientific and practical importance for the successful conduct of breeding work and dairy business [32].

In modern conditions of cultural cattle breeding, artificial selection plays a major role. When determining the effectiveness of selection, the following main indicators are usually taken into account: the degree of inheritance, selection differential, intergenerational interval, reliability of identifying the best animals, the number of traits for which selection is carried out, the degree of genetic and phenotypic variability of traits and the correlative relationships of traits among themselves. The degree of inheritance of a trait to a certain extent determines the rate of genetic improvement of the population in which this trait is selected. Almost all economically useful traits of dairy and beef cattle are quantitative and have a degree of inheritance sufficient for effective selection, which makes it possible to predict them [5]. However, selection for milk yield should not lead to a deterioration in other traits of milk production. At the same time, it is necessary to control the fat and protein content in milk and other traits at a level that ensures the production of high quality milk and the minimum requirements for technological properties that determine the suitability of cows for use on mechanised farms [17].

Therefore, the aim of our work is to evaluate and predict the organisation of reproduction, selection of cows according to the main economically useful traits among the livestock of modern Ukrainian breeds and to model the efficiency of selection at different intensities, which is very relevant from both a practical and scientific point of view.

Literature Review

Breeding is an important factor in the intensification of dairy farming. Modern methods of breeding involve the creation of highly productive animals that are well adapted to the least costly production technologies, taking into account objective assessment of their breeding qualities, application of population genetics and automated information systems for managing the breeding process. In particular important is the scientifically based selection of breeds, the direction and pace of increasing their genetic potential [24, 41].

F. Eisner believes that breeding work in cattle breeding is aimed at increasing dairy and meat productivity, improving product quality and reducing its cost of production. The main elements of breeding work are selection, selection, and breeding methods, reproduction techniques, targeted rearing of young animals, zootechnical and breeding and breeding records. In improving the breeding and productive qualities of animals, selection is crucial [11, 12]. That is why dairy cows are evaluated and selected for milk productivity, body type, live weight, intensity of milk production, origin; bulls — for body type, live weight, growth intensity, origin; young animals — for body type, origin [2, 8, 13].

Boning is an organisational measure for selecting animals on farms. According to its results, animals are divided into the following groups: the breeding nucleus, cows of the production cows to be culled and gelded, and a group of repair heifers, young animals for breeding sale, animals for fattening [23, 25].

After boning, breeding farms carry out individual selection, i.e. each cow is matched with a bull sire, taking into account its belonging to a particular line and family. In non-breeding farms, the group selection is used. For based on the genealogy of the herd, 2–3 bulls are selected for the breeding stock and assigned to them for two years [2]. Based on the boning materials, a herd recruitment plan is developed with breeding animals, determine the number of young animals that need to be raised for own needs and for sale to other farms.

On commercial farms, cows, heifers and calves older than 6 months of age. Cows are assessed for their origin, milk production, live weight, appearance, constitution, reproductive capacity and health. The entire herd is divided into three groups: breeding, production for milk production and production for meat production [14].

Every year, in order to improve the health and composition of the herd, we cull animals to the fattening group with subsequent sale for meat. This contributes to the growth of the intensity of reproduction and turnover of livestock, and enables a faster increase in of production. At the same time, the farm replenishes its cow herd with the help of its own production, i.e. growing animals and then transferring them to the appropriate groups.

However, there is a culling of young animals, which leads to a reduction in the number of cows (due to unsatisfactory development of the animal health service, animal care, and in modern conditions often due to lack of funds for the purchase of medicines and biological products) [9, 10].

In agricultural formations producing livestock products, it is necessary to carry out constant reproduction of the herd in order to ensure the number of livestock and rhythmic production of livestock products. This means organising timely replacement of retired animals due to aging, disease or other reasons.

According to the definition of A. S. Vsevykh [38], herd reproduction is the regular replacement of retired animals of the same purpose with younger and more highly productive ones. There are simple, extended and narrowed reproduction of the herd. It is divided into two parts — adult livestock and young animals of different ages. In this case, the adult breeding stock is classified as to fixed assets, and young stock to current assets [6].

The organisation of herd reproduction is determined by a number of natural (biological) and organisational and organisational and economic conditions. Biological conditions include the age of the first mating of sows, the period of their pregnancy, the cyclicity of the sow's heat and the time of its onset after childbirth, fertility and early maturity of animals, their life expectancy and economic use. Organisational and economic conditions include: customer orders for the production and sale of products, terms of their sale, transfer of animals through intra- and inter-farm cooperation, elimination of the stock of the breeding stock and increase of its fertility, timely culling of low-breed and low-productive animals, improvement of breeding qualities, provision of capital facilities, material, technical and labour resources.

In agrarian formations, herd reproduction is carried out in two main ways: by raising their own livestock and young animals and by purchasing them from other farms. A significant part of agrarian formations grows replacement young stock, creating a specialised farm for this purpose, while smallholder farms may not have such a farm [3].

In recent pre-war years, herd reproduction has become quite widespread, which is carried out on the basis of inter-farm cooperation, when specialised farms for rearing heifers or first-born cows, reproductive or other farms, reproductive or other farms. There are also breeding farms to provide agricultural units that producing livestock products with high-quality breeding stock. Hence, deepening specialisation and further development of inter-farm cooperation have an impact on the organisation of livestock reproduction, which leads to the creation of commercial farms for the cultivation of repairing young stock [18, 26].

D. T. Vinnichuk, P. M. Merezhko point out that the transfer of livestock to an industrial basis increases the requirements for the reproduction of livestock and herd completion of animals raised by complexes and farms. In these conditions, there is an intensive use of animals and shortening of their service life, and the need for repair of young animals. Since industrial-type farms and complexes have a much higher culling of adult animals with low productivity or unsuitable for industrial technology, and production on such farms and complexes is characterised by fluidity and rhythmicity, then every certain period of time the corresponding number of animals should be culled or sold. Therefore, the same number of them must be introduced into the herd [37].

Therefore, the level of renewal and culling of breeding stock. Given the high costs of breeding them it is in principle beneficial for each farm to use queens for as long as possible. However, this is only true if old queens retain high productivity and reproductive capacity not lower than the average in the herd. Therefore, it is justified, from both a zootechnical and economic point of view, a level of culling and renewal of the herd, which helps to increase its productivity and improve the quality of the herd.

The main requirements for the correct organisation of herd reproduction are: timely mating of repairing young stock, elimination of milkiness and increase of fertility of queens; complete preservation of offspring; improvement of breeding qualities of animals; timely culling of timely culling of low-productive and unsuitable for breeding animals [1, 26].

The rational structure of the herd can be established by taking into account certain organisational economic and biological factors. The main ones are the production direction of animal husbandry; the age of young animals sold for meat; the term of productive use of adult animals and the percentage of their annual culling; the number of calvings of sows per year and their fertility per calving; livestock growth rates. The decisive influence on the formation of the herd structure is the production direction of the livestock sector. A corresponding herd structure is characterised for each direction [41].

In the process of herd reproduction, quantitative changes occur in its composition and structure in connection with the receipt and rearing of offspring, the transfer of young animals from younger groups to the older ones, and the sale of young animals from the use part of adult animals. There are also qualitative changes in the composition of the livestock by breed, age and productivity due to the implementation of the breeding plan and the selection of the best animals, culling of low-productive, old and sick animals, and the purchase of breeding animals.

It is necessary to study the structure of the herd, identify the changes that have occurred in it and give them economic assessment, i.e. to show how appropriate changes in the structure of the herd are in terms of increasing the volume of production, rational use of labour and feed resources and maximising profits. To do this, the actual level of the above indicators are compared with the calculated level that would have occurred under all actual conditions, but with the planned (basic) structure of the herd [34]. It is also necessary to study the breed composition for each group of animals, to determine the proportion of each breed in the total livestock to establish changes in the breed composition of the herd compared to the plan and data of previous years. When determining the economic efficiency of different breeds of animals, the following should be taken into account productivity, feed and labour costs per 1 animal and 1 tonne of production, costs and profit per 1 animal and 1 tonne of production. Analysis of the breed composition of the herd and calculation of the impact of this factor on the of this factor on the results of economic activity is carried out for each group and type of animals with the subsequent generalisation of the analysis results [40].

Another method of selection and breeding work when planning the structure of the herd is the timely introduction of first-born cows into the herd. It has been established that the selection of first-born cows by their own productivity is about twice as effective as selection by origin. Therefore, for reproduction of the herd, 78–82% of the received heifers are used in order to 100 cows to raise at least 34–35 first-born heifers. Breeding work with the herd is based on the principles of inter-farm specialisation. For the rational use of the obtained the firstborn cows, it is better to test them in control barns or control groups. To organise them, the oldest groups of cows should be fully or half disbanded groups of cows into milkers and put heifers in the vacant places [20, 32].

The question of whether to use the first-born heifer to repair the main herd should be decided before she is inseminated (during the first 2–3 months of lactation). Up to 30% of firstborns are subject to rejection and culling, this ensures the introduction of the most highly productive animals into the main herd. When using the first-born evaluation system based on their own productivity, there should be an increase in the repair herd of heifers — 85–90 average annual animals for every 100 cows. The service life of a highly productive cow should be at least 6 lactations, and cows with record milk production — up to 8 lactations. The most optimal age structure of the dairy herd can be as follows: first-born — 21–22%, the second calving — 18–19, the third — 16–17, the fourth — 14–15, the fifth and older — 27–32%. It is desirable to carry out targeted recruitment of the best herds with the most productive first-born cows [28].

Thus, selection methods in planning the structure of the animal herd should be aimed at creating dairy herds that would have high productivity, good health strong constitution, suitable for machine milking, adapted to the conditions of and the accepted technology of milk production, and to pass on their qualities to their offspring in a sustainable manner.

Therefore, the goal of the research was: to determine the effectiveness of selection of dairy cows at different intensities. To achieve this goal, the following tasks were set: to assess the hereditary potential of female cattle ancestors; to conduct a comparative analysis of the milk production of cows of different breeds — Ukrainian Red Dairy (URD), Ukrainian Black Speckled Dairy (UBSD) and Ukrainian Red Speckled Dairy (URSD); to study the peculiarities of growth and development of females and their relationship with milk production; to evaluate the reproductive traits of cows; to investigate the level of inheritance of the main traits of animal selection; to model the selection effect and evaluate its implementation in cattle herds.

Materials and Methods

The research was carried out on the basis of "Kolos 2011" LLC located in the Matrosivka village, Ochakiv district, Mykolaiv region in the period 2020–2024. Object of research: analysis of the dynamics of selection traits under the influence of different selection pressures. Subject of research: the degree of inheritance of traits at different selection intensity in dairy cows.

The study analysed the selection and breeding work on the farm, breeding and reproduction of the herd, veterinary and sanitary conditions, mechanisation of production processes, organisation and remuneration of labour. The materials used in this study were production activities, zootechnical, production and accounting records kept on the farm. The study of the main selection traits was based on the methods generally accepted in zootechnology [7, 22, 40].

The formula [4] was used to determine the level of inheritance of selection traits:

$$h^2 = 2 \times r \qquad (1),$$

where h^2 is inheritance rate;
r is a correlation between mother and daughter traits.

The following formulas were used to model the selection effect [3, 11, 12]:

$$SE = Sd \times h^2 \qquad (2),$$

where SE is a selection effect;
Sd is a selection differential.

$$Sd = X_{bc} - X_{hr} \qquad (3),$$

where X_{bc} is the average productivity of animals of the breeding nucleu;
X_{hr} is the average productivity of the herd.

$$X_{bc} = X_{hr} + \delta \times i \qquad (4),$$

where i is an intensity of selection (15, 30, 45%).

i = 1,5486, u = 1,04; i = 1,1617, u = 0,52; i = 0,8791, u = 0,13 respectively.

$$X_u = X_{hr} + u \times \delta \qquad (5),$$

where X_u is a breeding limit.

The indicators of the investigated traits were determined according to generally accepted algorithms of variation statistics in animal husbandry. The average values of the females of the herd were taken as the control group in the experiment without determining the breed.

At the final stage of the research, conclusions and proposals were drawn up, including suggested measures.

Results and Discussion

The genetic potential is a set of genetic information carriers that determine the ability of animals to produce products under certain conditions of feeding, housing, use, etc. This indicates the relevance of research aimed at a comprehensive solution to the problem of

Table 1. Milk yield of female ancestors of cows (for 305 days, kg) for higher lactation

Breed	*n*	The level of development of the trait and its variability and probability				
		$\bar{X}\pm S_x$	σ	C_v	$d\pm S_d$	t_d
Mothers						
URD	30	5405±313.0	1713	31.7	−203±368	0.55
UBSD	30	5656±425.0	2328	41.2	48±467	0.10
URSD	30	5762±254.6	1394	24.2	154±320	0.48
On average	90	5608±193.8	1838	32.8	×	×
Mothers of mothers						
URD	30	4578±160.3	878	19.2	−1143±248	4.6^{***}
UBSD	30	7072±363.0	1988	28.1	1351±410	3.29^{**}
URSD	30	5511±255.3	1398	25.4	−210±318.2	0.65
On average	90	5721±189.9	1802	31.5	×	×
Mothers of fathers						
URD	30	8712±260.1	1424	16.4	−865±343	2.52^{*}
UBSD	30	10180±309.0	1693	16.6	603±381	1.58
URSD	30	9840±505.8	2770	28.1	263±553	0.47
On average	90	9577±223.4	2120	22.1	×	×

Table 2. Fat content in milk (%) of female progenitors of cows for higher lactation

Breed	*n*	The level of development of the trait and its variability and probability				
		$\bar{X}\pm S_x$	σ	C_v	$d\pm S_d$	t_d
Mothers						
URD	30	3.76±0.032	0.17	4.73	−0.01±0.035	0.28
UBSD	30	3.75±0.026	0.14	3.73	−0.02±0.030	0.67
URSD	30	3.80±0.015	0.08	2.22	0.03±0.02	1.5
On average	90	3.77±0.015	0.14	3.70	×	×
Mothers of mothers						
URD	30	3.72±0.030	0.17	4.44	−0.04±0.037	1.08
UBSD	30	3.83±0.058	0.32	8.24	0.07±0.062	1.13
URSD	30	3.73±0.023	0.13	3.48	−0.03±0.032	0.93
On average	90	3.76±0.023	0.22	5.90	×	×
Mothers of fathers						
URD	30	4.31±0.060	0.33	7.69	0.10±0.075	1.33
UBSD	30	4.36±0.102	0.56	12.81	0.15±0.111	1.35
URSD	30	3.97±0.049	0.27	6.78	−0.24±0.047	5.10^{***}
On average	90	4.21±0.046	0.44	10.37	×	×

Table 3. Amount of milk fat (kg) of female progenitors of cows during higher lactation

Breed	*n*	The level of development of the trait and its variability and probability				
		$\bar{X}\pm S_x$	σ	C_v	$d\pm S_d$	t_d
Mothers						
URD	30	204±12.3	67.2	32.9	−7±14.3	0.48
UBSD	30	212±16.2	88.9	41.9	1±17.8	0.05
URSD	30	218±9.3	50.8	23.2	7±11.9	0.59
On average	90	211±7.4	70.2	33.2	×	×
Mothers of mothers						
URD	30	170±6.2	33.8	19.8	−46±9.7	4.74^{***}
UBSD	30	271±14.5	79.4	29.3	55±16.3	3.37^{**}
URSD	30	206±9.8	53.5	25.9	−10±12.3	0.81
On average	90	216±7.5	71.5	33.1	×	×
Mothers of fathers						
URD	30	376±13.4	73.2	19.4	−31±17.9	1.73
UBSD	30	450±23.3	127.9	28.4	43±26.2	1.64
URSD	30	393±21.9	120.1	30.5	−14±24.9	0.56
On average	90	407±11.9	113.0	27.8	×	×

accelerating the pace of genetic progress in dairy cattle breeding through theoretical substantiation and practical implementation of methodological principles for evaluating and selecting animals by a set of traits and creating an improved breeding system on this basis [16, 21]. Therefore, the genetic potential of cows of modern Ukrainian breeds created with the involvement of the world's best gene pool was studied and their influence on the degree of its implementation in dairy cattle herds was established. Thus, having assessed the hereditary potential of cows of the experimental stock in terms of milk yield, it should be noted that mothers have a milk yield of at least 5000 kg. Mothers of URSD cows have a higher value — 5762 kg (table 1).

The difference with the control group is 154 kg. At the same time, Ukrainian red dairy ancestors are characterised by the lowest milk yields. The difference in favour of the control values is 203 kg of milk. The mothers of the mothers are characterised by slightly lower productivity indicators with a fairly wide range of variation from the control group — from 210 to 1351 kg. In this generation of ancestors. the highest values of milk yield are inherent in the UBSM cattle — 7072 kg (P>0.99) while its lowest values are in the URSD breed — 4578 kg. They are significantly inferior to the control data by 1143 kg (P>0.999). The highest values of the hereditary potential for milk yield are characterised by mothers of fathers whose level of trait development reaches more than 10000 kg of milk. The female ancestors of the URD breed have lower milk yields — 8712 kg. which are 865 kg less than the control animals with a probability of P>0.95. The mothers of the fathers of the UBSD breed have the highest productivity indicators — 10180 kg. which exceed the control values by 603 kg. Among the last two generations of female ancestors. another Ukrainian diary breed (Red Speckled) occupies an intermediate place in terms of milk yield development.

When assessing the hereditary potential for fat content in milk. we observe a fairly high level of its manifestation. Mothers of the URSD breed have a milk fat content of 3.80%, which is the highest advantage over the control group of animals — 0.03%. The fat content of mothers of the other two breeds (URD and UBSD) does not differ significantly from each other — 3.76 and 3.75%, respectively (table 2).

The trend of fat content in milk among mothers has changed somewhat. Thus, female progenitors of the UBSD breed are characterised by higher values — 3.83%, which is 0.07% higher than the control indicator. The fat content of the URD and URSD breeds also does not differ significantly (3.72 and 3.73%). Mothers of fathers of the experimental groups of cows have the highest fat content in milk — 3.97–4.36%. The largest fluctuation from the control data was observed in the mothers of fathers of URSD breed by 0.24% in favour of the former with a reliability of P>0.999. The other two experimental groups of female ancestors, on the contrary, exceed the control group by 0.10 and 0.15%, although the difference is not significant.

The female ancestors are also characterised by a fairly high hereditary potential in terms of the amount of milk fat (table 3). For mothers, the highest amount of milk fat is inherent in URSD cows — 218 kg, which is 7 kg more than the control data. A similar trend is observed among the mothers of the URD breed. but they are already inferior to the control indicators. Among the mothers, a higher level of development of this trait is already characteristic of the UBSD breed — 271 kg which is significantly (P>0.99) higher than the control value by 55 kg. Similarly to the previous group of ancestors, the lowest level of development of the trait is inherent in the ancestors of the URD breed — only 170 kg of milk fat which is a difference of 46 in favour of control animals (P>0.999). A similar trend is observed among the mothers of the fathers. Thus, representatives of the URD breed are characterised by lower values of milk fat — 376 kg compared to the other two breeds — UBSD (450 kg) and URSD (393 kg) but this difference is not significant.

Characterising the milk yield of cows of different breeds during the first lactation, we note that it is quite high for first-calf cows — from 4974 to 6210 kg of milk. and the maximum is observed in UBSD cows — 6210 kg; they exceed the control group by 743 kg with a significant difference (P>0.999). The lowest milk yield is characteristic of URSD cows (4974 kg). Their difference with the control group in favour of the latter is 493 kg. The trend of milk yield for the second lactation has changed and the cows of URD cattle are characterised by lower milk yields — only 5964 kg. They are 383 kg lower than the control data (table 4).

The other two experimental groups of cows (URSD and UBSD) exceeded the control group by 258 and 641 (P>0.95) kg of milk, respectively. The data of the third lactation confirm that again no clear advantage in milk yield was found. Thus, the maximum milk yield was 7124 kg, with an advantage over the control group of 676 kg of milk. The other two experimental groups of cows are inferior to the control data. The minimum advantage is observed in UBSD cattle — only 31 kg. The analysis of higher lactation showed that the URSD cattle again had the lowest milk yield, which reached a level of only 6978 kg. The maximum milk yield of the UBSD breed is 7593 kg, which is 301 kg higher than the control values. The other experimental group of cows occupies an intermediate place, but exceeds the indicator of the control group.

Our comparative analysis of the fat content in milk suggests that during the first lactation, it varies from the control group by ±0.01%. UBSD cows have the highest fat content in milk (3.81%). Two other Ukrainian breeds have the same level of development of this trait within 3.79% (table 5). Indicators of the second lactation in terms of fat content in milk, compared to the first slightly, decreased (3.73–3.80%). But its maximum manifestation is also inherent in UBSD cows — 3.80% with an advantage over control animals by 0.04%. On the contrary, URSD cattle have the lowest fat content in milk — 3.73%. The fat content in milk during the third lactation changed its direction again. Thus, UBSD cows have the lowest fat content (3.79%), which is 0.03% less than the control data. At the same time, the URSD cattle of the same age showed the maximum fat content — 3.85% and their advantage over the control values is 0.03%. The comparative characterisation of this trait for higher lactation again does not give unambiguous results. The two Ukrainian speckled dairy breeds, Black and Red, have the same fat content of 3.77%, which is the lowest compared to URD cattle (3.79%).

Table 4. Milk yield in cows of different breeds for 305 days of lactation, kg

Breed	n	The level of development of the trait and its variability and probability				
		$\bar{X}\pm S_x$	σ	C_v	$d\pm S_d$	t_d
First lactation						
URD	30	5216±258.2	1415	27.1	−251±290.6	0.86
UBSD	30	6210±153.4	841	13.5	743±203.3	3.65**
URSD	30	4974±210.8	1150	23.1	−493±249.5	1.97
On average	90	5467±133.4	1266	23.1	×	×
Second lactation						
URD	30	5964±264.1	1444	24.2	−383±309.5	1.24
UBSD	30	6988±257.5	1410	20.2	641±303.9	2.11*
URSD	30	6089±288.4	1575	25.9	−258±330.5	0.78
On average	90	6347±161.4	1532	24.1	×	×
Third lactation						
URD	30	7124±352.6	1928	27.1	676±432.3	1.56
UBSD	30	6417±479.5	2626	40.9	−31±540.8	0.06
URSD	30	5802±439.1	2403	41.4	−646±505.4	1.28
On average	90	6448±250.2	2374	36.8	×	×
The highest lactation						
URD	30	7304±305.4	1673	22.9	12±258.2	0.05
UBSD	30	7593±257.8	1412	18.6	301±153.4	1.96
URSD	30	6978±269.5	1475	21.1	−314±210.8	1.49
On average	90	7292±161.1	1528	20.9	×	×

Table 5. Fat content in milk (%) of cows of different breeds

Breed	n	The level of development of the trait and its variability and probability				
		$\bar{X}\pm S_x$	σ	C_v	$d\pm S_d$	t_d
First lactation						
URD	30	3.79±0.023	0.13	0.35	−0.01±0.026	0.38
UBSD	30	3.81±0.019	0.10	2.73	0.01±0.023	0.43
URSD	30	3.79±0.025	0.14	3.60	−0.01±0.028	0.36
On average	90	3.80±0.013	0.12	3.22	×	×
Second lactation						
URD	30	3.76±0.024	0.13	3.51	0	0
UBSD	30	3.80±0.021	0.12	3.08	0.04±0.028	1.43
URSD	30	3.73±0.026	0.14	3.87	−0.03±0.029	1.03
On average	90	3.76±0.014	0.13	3.55	×	×
Third lactation						
URD	30	3.81±0.022	0.12	3.18	−0.01±0.025	0.40
UBSD	30	3.79±0.024	0.13	3.52	−0.03±0.027	1.11
URSD	30	3.85±0.024	0.13	3.39	0.03±0.027	1.11
On average	90	3.82±0.013	0.13	3.38	×	×
The highest lactation						
URD	30	3.79±0.022	0.12	3.15	0.01±0.026	0.38
UBSD	30	3.77±0.021	0.12	3.09	−0.01±0.025	0.40
URSD	30	3.77±0.031	0.17	4.46	−0.01±0.034	0.29
On average	90	3.78±0.014	0.13	3.59	×	×

We also evaluated the amount of milk fat in cows of the experimental groups (table 6). A higher amount of milk fat during the first lactation was observed in UBSD cows (237 kg), which is 29 kg higher than the control data with a significant difference (P>0.99). The other two groups of animals have no significant difference between them and are characterised by the amount of milk fat in the range of 190–198 kg. A similar trend is observed in the second lactation. UBSD cows have a higher manifestation of this trait — 265 kg with a probable advantage over the control data of 26 kg (P>0.95). The other two experimental groups of cows do not have a significant difference between them and are inferior to the control indicator by 15 and 12 kg of milk fat. The degree of manifestation of the amount of milk fat in the third lactation has changed slightly and the best cows were URD breed — 271 kg. The other two breeds have lower values of milk fat and are inferior to the control data. Analysing the highest lactation by the level of development of this trait, we note again the natural tendency of the UBSD cows to be superior — 287 kg. At the same time, the minimum amount of milk fat is inherent in URD cows (263 kg).

Table 6. Amount of milk fat (kg) in cows of different breeds

Breed	n	The level of development of the trait and its variability and probability				
		$\overline{X}\pm S_x$	σ	C_v	$d\pm S_d$	t_d
First lactation						
URD	30	198±10.5	57.4	28.9	−10±11.8	0.85
UBSD	30	237±6.0	33.1	13.9	29±8.1	3.58**
URSD	30	190±8.7	47.6	25.1	−18±10.2	1.76
On average	90	208±5.4	50.9	24.5	×	×
Second lactation						
URD	30	224±9.6	52.6	23.5	−15±11.3	1.33
UBSD	30	265±9.7	52.9	19.9	26±11.4	2.28*
URSD	30	227±10.4	57.3	25.3	−12±12.0	1.0
On average	90	239±6.0	57.0	23.9	×	×
Third lactation						
URD	30	271±13.2	72.2	26.7	26±16.2	1.60
UBSD	30	242±17.9	98.2	40.5	−3±20.2	0.15
URSD	30	222±16.5	90.4	40.7	−23±18.9	1.22
On average	90	245±9.4	88.9	36.3	×	×
The highest lactation						
URD	30	277±11.6	63.5	22.9	2±13.1	0.15
UBSD	30	287±9.7	53.4	18.6	12±11.4	1.05
URSD	30	263±10.4	56.9	21.7	−12±12.0	1.00
On average	90	275±6.1	58.3	21.1	×	×

Table 7. Dynamics of lactation duration (days) in cows of different breeds

Breed	n	The level of development of the trait and its variability and probability				
		$\overline{X}\pm S_x$	σ	C_v	$d\pm S_d$	t_d
First lactation						
URD	30	330±11.0	60.3	18.3	−4±12.9	0.31
UBSD	30	348±11.4	62.4	17.9	14±13.3	1.05
URSD	30	325±12.8	69.9	21.5	−9±14.5	0.62
On average	90	334±6.8	64.4	19.2	×	×
Second lactation						
URD	30	342±15.7	85.9	25.1	3±17.5	0.17
UBSD	30	349±13.7	74.9	21.4	10±15.7	0.63
URSD	30	326±10.4	56.9	17.4	−13±12.9	1.00
On average	90	339±7.7	73.3	21.6	×	×
Third lactation						
URD	30	354±18.2	99.5	28.1	40±21.3	1.88
UBSD	30	315±19.5	107.3	33.9	1±22.5	0.04
URSD	30	274±18.3	100.5	36.6	−40±21.4	1.87
On average	90	314±11.2	106.4	33.8	×	×
The highest lactation						
URD	30	360±13.6	74.4	20.6	10±15.3	0.65
UBSD	30	357±13.5	73.8	20.7	7±15.2	0.46
URSD	30	334±7.9	43.1	12.9	−16±10.5	1.52
On average	90	350±6.9	65.7	18.7	×	×

Cows of Ukrainian Black Speckled and Red Speckled dairy breeds are characterised by high genetic potential in terms of milk production and reproductive capacity. However, in herds that currently have a high proportion of heredity for the Holstein breed, there is a deterioration in the main indicators of reproductive capacity.

One of the most significant indicators that affects the level of productivity and reproductive capacity of cows is the duration of lactation or the number of milk days. In particular, the number of lactation days has a 21.1% influence on milk yield, and the amount of milk fat — 19.7% [36]. It has been established that the most economically profitable animals are those that lactate for 305 days and give birth to one calf per year. To ensure such a long lactation period, it is necessary to inseminate cows after calving in the third heat. This makes it possible to increase the service period to 60 days and the lactation period during pregnancy to 245 days. Even a slight improvement in reproductive performance leads to an increase in milk production in cows, therefore, it is necessary to strive to maintain the optimal periodicity of pregnancy in cows, which in turn will contribute to the growth of productivity in the herd [25]. Therefore, the research was aimed at conducting a comparative analysis of the duration of lactation in cows bred with and without the Holstein breed. Thus, the dynamics of the duration of the first lactation, based on the data in table 7, slightly exceeds the generally accepted norms — 305 days. Speaking in terms of breeds, it should be noted that URSD cows have the lowest number of milk days (325 days). At the same time, representatives of the URD breed do not have Holstein blood in their genotype and do not differ in its lowest manifestation — 330 days. And accordingly, the longest lactation is characteristic of UBSD cows (348 days). A similar trend is observed in the context of the second lactation, where the largest number of milk days is observed in UBSD cattle — 349 days, and the smallest (326 days) — in cows of another Ukrainian breed, in the creation of which Holsteins took part. The data of the third lactation in terms of its duration are somewhat different from the above trends. Namely, the cows bred by Holstein sires have the most optimal lactation duration of 274 and 315 days, which is almost within the zootechnical standards. At the same time, URD cows have the longest lactation period — 354 days, which is significantly higher than the accepted norms and is not economically viable. The analysis of higher lactation also suggests that milk production in this farm during this period is economically unprofitable, as the number of milking days is almost one year.

In production conditions, animals are forced to adapt to new conditions with the stress of their physiological systems, which subsequently leads to poor health and the development of stress. It is this condition that negatively affects productivity and product quality, causing large losses to economic activity [7]. In cattle breeding, some animals have the ability to quickly adapt to the latest technologies and conditions, others are slower or not capable of such adaptation at all. In the industry, up to 30% of highly productive cows are culled annually for this reason, thereby causing losses to the farm, both the failure to obtain a significant amount of milk from them and the failure to select young animals of breeding value [40]. Machine milking of lactating animals is now almost completely mechanised, but not all farms have a high level of cow productivity. That is why, in order to obtain high milk production in this way, knowledge of the biological basis of lactation function and the ability to use it in dairy farming practice is necessary [42]. Milking is a complex biotechnological process where, with the help of a machine, human influence is directed to the living organism of cows. and the value of productivity per lactation depends on the fullness of interaction between them [3]. Therefore, the purpose of our research was to trace the degree of adaptation of high-yielding cows to the technology of machine milking, depending on their breed. Thus, it should be noted that in the context of the studied lactations, the intensity of milk production of all breeds without exception is in the optimal range of 1.83–2.01 kg/min. (table 8). The maximum intensity of milk production in UBSD cows is also noteworthy, which in the context of all studied lactations was 1.96–2.02 kg/min. Other first-born cows had the intensity of milk production at the level of 1.83–1.87 kg/min, which is 0.05–0.01 kg/min lower than that of UBSD cows. Regarding the intensity of milk production in experimental cows with two calvings, it was practically at the same level in Ukrainian Red Speckled and Red dairy animals — 1.81 and 1.85 kg/min. And as already noted, the best intensity of milk production is inherent in UBSD cows — 2.01 kg/min. The data on milk production of cows at an older age after the third calving do not differ significantly.

According to the best practices, intensive growth and development of repair heifers largely determines the desired body type of adult animals and, as a result, allows to maximise the hereditary potential of the subsequent milk production of cows [7, 10]. From the production point of view, the early maturity of repair heifers reduces the unproductive period of growing from birth to calving. From the selection point of view, it accelerates the process of evaluating bulls by the quality of offspring and promotes intensive reproduction of the herd, which ultimately significantly determines the level of profitability of dairy farming [22, 40]. In addition, it was found that the value of live weight of heifers at the end of the growing period and the beginning of the mating period is positively correlated with the subsequent milk production for the first and other lactations [35, 39].

Table 8. Dynamics of milk production rate (kg/min) in cows of different breeds

Breed	n	The level of development of the trait and its variability and probability				
		$\overline{X}\pm S_x$	σ	C_v	$d\pm S_d$	t_d
First lactation						
URD	30	1.83±0.015	0.08	4.44	−0.05±0.019	2.63*
UBSD	30	1.96±0.031	0.17	8.63	0.08±0.034	2.35*
URSD	30	1.87±0.011	0.06	3.35	−0.01±0.017	0.59
On average	90	1.88±0.013	0.13	6.69	×	×
Second lactation						
URD	30	1.81±0.015	0.08	4.62	−0.08±0.022	3.64**
UBSD	30	2.01±0.035	0.19	9.56	0.12±0.038	3.16**
URSD	30	1.85±0.009	0.05	2.61	−0.04±0.018	2.22*
On average	90	1.89±0.016	0.15	7.98	×	×
Third lactation						
URD	30	1.85±0.010	0.05	3.02	−0.05±0.019	2.63*
UBSD	30	2.01±0.037	0.20	10.18	0.11±0.040	2.75**
URSD	30	1.84±0.017	0.09	5.25	−0.06±0.023	2.60*
On average	90	1.90±0.016	0.15	8.16	×	×
The highest lactation						
URD	30	1.85±0.011	0.06	3.23	−0.06±0.019	3.15**
UBSD	30	2.02±0.037	0.20	10.03	0.11±0.039	2.82**
URSD	30	1.86±0.010	0.05	2.80	−0.05±0.018	2.77**
On average	90	1.91±0.015	0.15	7.74	×	×

According to M. Zubets and co-authors [43], an integral part of the advanced selection of dairy cattle is the evaluation of breeding animals at an early age and at different stages of their individual development. In this case, the main method of morphological studies of animal growth involves recording live weight. The results of these observations are indicators of animal growth and development, which characterise the intensity of metabolic processes occurring in the body. Therefore, taking into account the relevance of this issue, we studied the features of growth and development of heifers and their ability to high growth intensity under appropriate growing conditions, and how the latter affects their productivity. Thus, having carried out (table 9) an assessment of live weight at birth, it should be noted that cows in the genotype of which there is the presence of Holstein blood are distinguished by a higher live weight at birth — UBSD (30.9 kg), URSD (33.8 kg).

Moreover, the latter significantly exceed the control values by 2.7 kg (P>0.99), compared to URD cattle (only 28.4 kg), which are inferior to the control group at the third level of probability (P>0.999). The dynamics of live weight at three months has changed somewhat. there is an unusual variability in the growth and development of cows originating from the Holstein breed — heifers of the URD group, on the contrary, they are characterised by the highest live weight, which reaches 88.9 kg, compared to two other Ukrainian Black Speckled and Red Speckled breeds — 82.9 and 85.6 kg, respectively. By the way, UBSD cattle, unlike the previous period, has the lowest live weight. A similar trend is observed in the following age periods at the age of six and nine months: URD heifers exceed their URSD and UBSD peers in terms of live weight development, and the latter generally have the lowest live weight in the above two age periods. At twelve months of age, there were also changes in the growth and development of heifers. Although URD cattle remained the leader in terms of live weight — 228.6 kg among the animals of the other two Ukrainian breeds, there was a rotation. That is, the UBSD cattle of the same age grew and gained weight slightly better than their Red Speckled counterparts — 209.3 and 207.4 kg, respectively. A similar trend is observed at the age of fifteen months — the advantage remains in favour of the URD breed with 265.1 kg. However, the UBSD cattle of the same age as the URSD cattle used feed better and the difference in weight between them and the representatives of the first group decreased to 10 kg. The level of live weight development at the age of eighteen months has a similar manifestation to the previous age period. At the end of the growing period, at the age of twenty-four months, the live weight of URD and UBSD cows almost levelled off and amounted to 326.1 and 325.7 kg, respectively. At the same time, the URSD cattle of the same age were significantly inferior to them in terms of live weight development (only 287.9 kg, P>0.99), that is within 30 kg less than the above-mentioned breeds.

Table 9. Dynamics of live weight (kg) of heifers, heifers and cows of different breeds

Breed	*n*	The level of development of the trait and its variability and probability				
		$\overline{X}\pm S_x$	σ	C_v	$d\pm S_d$	t_d
At birth						
URD	30	28.4±0.25	2.86	10.1	−2.7±0.54	5.0^{***}
UBSD	30	30.9±0.83	4.55	14.7	−0.2±0.96	0.21
URSD	30	33.8±0.83	4.53	13.4	2.7±0.96	2.81^{**}
On average	90	31.1±0.48	4.58	14.8	×	×
3 months						
URD	30	88.9±2.05	11.23	12.6	3.1±2.47	1.25
UBSD	30	82.9±2.74	15.03	18.1	−2.9±3.07	0.94
URSD	30	85.6±2.25	12.33	14.4	−0.2±2.64	0.07
On average	90	85.8±1.38	13.05	15.2	×	×
6 months						
URD	30	150.1±4.55	24.90	16.6	13.6±5.20	2.61^{*}
UBSD	30	126.5±4.30	23.54	18.6	−10.0±4.98	2.0
URSD	30	132.8±2.97	16.27	12.25	−3.7±3.89	0.95
On average	90	136.5±2.52	23.88	17.5	×	×
9 months						
URD	30	182.3±3.97	21.73	11.9	9.9±4.96	1.99
UBSD	30	164.2±6.19	33.91	20.6	−8.2±6.86	1.19
URSD	30	170.8±4.64	25.43	14.9	−1.6±5.51	0.29
On average	90	172.4±2.97	28.20	16.3	×	×
12 months						
URD	30	228.6±5.95	32.61	14.3	13.5±7.18	1.88
UBSD	30	209.3±7.80	42.71	20.4	−5.7±8.78	0.65
URSD	30	207.4±6.54	35.83	17.3	−8.0±7.68	1.04
On average	90	215.1±4.02	38.10	17.7	×	×
15 months						
URD	30	265.1±6.86	37.60	14.2	13.8±8.34	1.65
UBSD	30	254.4±10.11	55.36	21.8	3.1±11.17	0.28
URSD	30	234.5±6.45	35.34	15.1	−16.8±8.01	2.10^{*}
On average	90	251.3±4.75	45.05	17.9	×	×
18 months						
URD	30	299.9±8.16	44.72	14.9	16.6±9.85	1.68
UBSD	30	289.8±11.95	65.44	22.6	6.5±13.16	0.49
URSD	30	260.3±6.46	35.39	13.6	−23±8.50	2.70^{*}
On average	90	283.3±5.52	52.35	18.5	×	×
24 months						
URD	30	326.1±8.47	46.39	14.2	12.9±10.32	1.25
UBSD	30	325.7±12.98	71.07	21.8	12.5±14.26	0.88
URSD	30	287.9±6.92	37.89	13.2	−25.3±9.09	2.78^{**}
On average	90	313.2±5.90	56.03	17.9	×	×

In the process of ontogenesis, hereditary transmission and variability of maternal traits are carried out as a result of genotype and environmental conditions. During growth and development, an animal acquires not only breed and species characteristics, but also peculiar features of constitution, appearance and productivity [25, 41]. Therefore, the study of individual animal development is of great scientific and practical importance, as it allows for the selection and cultivation of the most valuable individuals — the fathers of the next generations.

In all countries of the world of intensive livestock production, the assessment of the appearance and constitution of animals is used. In the context of modern housing technologies that require standardisation of animals by key indicators, a comprehensive assessment of dairy cattle is required, in which body type assessment and selection is becoming increasingly important. Evaluation of body type is included as a component of all breeding programmes when improving existing and creating new types and breeds [41]. For the successful operation of animals in industrial technology, dairy cows must be distinguished by the appropriate exterior type: strong body structure, developed body, strong hooves and correct limb position, appropriate mofological and functional properties of the udder. Animals with well-developed traits are usually characterised by higher productivity and a longer service life [42].

Since breeds and intrabreed types of dairy cattle in Ukraine have certain differences in appearance due to the use of a multi-breed maternal basis in the process of their creation and different options for selection and selection even within individual breeding herds, the study of cows of modern URD, URSD and UBSD breeds to determine the main traits of the exterior and their influence on milk production are considered relevant from both scientific and practical points of view, which was the purpose of our research. Thus, the assessment of the height at the withers (table 10) shows that its highest value is observed among UBSD cows — 134 cm and their superiority over the control data by 2 cm with a significant difference (P>0.99). URD cattle, on the contrary, are inferior to all experimental groups in this respect (131 cm) and URSD breed peers have similar data on withers to control animals — 132 cm.

Oblique length has slightly different characteristics. Thus, URD cows have the highest development of

160 cm and significantly exceed the control group by 2 cm (P>0.95). And representatives of two other Ukrainian breeds, Black Speckled and Red Speckled, have the same degree of oblique body length development — 157 cm, which is probably due to their common origin.

The degree of development of the chest, which is characterised by the depth of the chest and its width, is better in UBSD cattle — 73 and 46 cm, respectively. Another dairy breed, the URSD, is also characterised by good chest development: 72 and 45 cm, respectively. Slightly smaller measurements are inherent in URD cattle — 71 and 44 cm, respectively. The first two breeds, regarding the research, are potentially capable of producing more milk because their rib cage is somewhat better developed compared to URD cattle. A somewhat different trend is observed in the development of the chest girth, where a better degree of development is observed in URSD cows (206 cm), while its values are worse in UBSD cows (203 cm). Its differences with the control group are within ±1–2 cm.

No significant difference in the level of development of the metacarpal girth was found; its value in cows of the experimental groups is in the range of 19.5–19.9 cm with fluctuations from the control values at the level of 0.1–0.3 cm.

The degree of development of the width of the hindquarters in makloks among cows of all experimental breeds has the same value — 51 cm and no absolute difference between them was found.

In the context of intensification and specialisation of dairy farming on an industrial basis, high productivity and regular reproduction of animals determine the profitability of breeding farms. The high intensity of animal selection, which is the basis for the genetic progress of the herd, places high demands on the reproductive function of animals [1]. Increasing the level of reproductive function in cattle breeding has always been problematic and is currently of great practical and scientific interest, especially to highly productive animals and animals of new genotypes, since reproductive disorders, primarily in cattle, reduce the period of economic use, reduce the level of milk production, and at the same time the profitability of the industry as a whole [7].

The level of reproductive capacity of cows is significantly influenced by the proportion of heredity for the improving breed. With the increase of conditional bloodlines in the Holstein breed, the reproductive capacity of cows improves [15]. But there are also opposing statements [29, 41]. Therefore, we set out to investigate the level of reproductive capacity of cows that were created using the best world gene pool under the conditions of a given farm.

When making a comparative assessment of the duration of the service period, it should be noted that among all the studied groups it is significantly extended — 128–132 days, which will have a negative impact on the profitability of milk production. The lowest number of days from calving to fertile insemination is spent by URSD dairy cows — 128 days, and the highest — by the peers of the other group — UBSD — 132 days (table 11). The variation from the control group is ±2 days.

Table 10. Linear measurements (cm) of first-born cows of various breeds

Breed	n	The level of development of the trait and its variability and probability				
		$\overline{X}\pm S_x$	σ	C_v	$d\pm S_d$	t_d
Height at the withers						
URD	30	131±0.5	2.59	1.9	−1±0.58	1.72
UBSD	30	134±0.5	3.05	2.3	2±0.58	3.44**
URSD	30	132±0.5	2.93	2.2	0	0
On average	90	132±0.3	3.02	2.3	×	×
Oblique body length						
URD	30	160±0.7	4.16	2.6	2±0.92	2.17*
UBSD	30	157±1.0	5.65	3.6	−1±1.17	0.85
URSD	30	157±1.4	7.99	5.1	−1±1.52	0.66
On average	90	158±0.6	6.28	4.0	×	×
Chest depth						
URD	30	71±0.7	3.92	5.5	−1±0.81	1.23
UBSD	30	73±0.6	3.21	4.4	1±0.72	1.39
URSD	30	72±0.7	3.83	5.3	0	0
On average	90	72±0.4	3.69	5.1	×	×
Chest width						
URD	30	44±0.7	3.62	8.2	−1±0.81	1.23
UBSD	30	46±0.5	3.06	6.6	1±0.64	1.56
URSD	30	45±0.8	4.26	9.5	0	0
On average	90	45±0.4	3.72	8.3	×	×
Chest circumference						
URD	30	205±1.9	10.42	5.1	1±2.15	0.46
UBSD	30	203±1.6	8.79	4.3	−1±1.89	0.53
URSD	30	206±1.7	9.56	4.6	2±1.97	
On average	90	204±1.0	9.59	4.7	×	×
Metacarpal girth						
URD	30	19.9±0.31	1.69	8.5	0.3±0.34	0.88
UBSD	30	19.6±0.24	1.30	6.7	0	0
URSD	30	19.5±0.28	1.52	7.8	−0.1±0.32	0.31
On average	90	19.6±0.16	1.51	7.7	×	×
Width in macklacks						
URD	30	51±0.5	2.77	5.4	0	0
UBSD	30	51±0.5	2.57	5.0	0	0
URSD	30	51±0.4	2.42	4.7	0	0
On average	90	51±0.3	2.57	5.0	×	×

The analysis of the duration of the dry period in the context of the studied livestock did not reveal any significant differences from physiological and zootechnical standards. Thus, in URD and UBSD cows it is 63, 62 days, respectively, and only in URSD there is a slight increase to 72 days. The differences with the control group are ±2–7 days.

The evaluation of the cow insemination index gives us negative results. Because the insemination index is the number of inseminations spent on one insemination. Thus, insemination results are considered optimal if the index is 1.5: good — 1.6–1.8; satisfactory — 1.9–2.0; poor — 2.1 and more. Based on our calculations, the insemination index in this farm is very poor — 6.40–6.59. Its lowest value is observed in URSD cows (6.40), which is far from even a satisfactory state of reproductive function. The value of the insemination index in the URD breed peers is even higher — 6.52 and its maximum value is noted in UBSD cattle (6.59).

Table 11. Characteristics of the reproductive function in cows of different breeds

Breed	n	The level of development of the trait and its variability and probability				
		$\overline{X}\pm S_x$	σ	C_v	$d\pm S_d$	t_d
Duration of the service period (for higher lactation), days						
URD	30	130±15.9	87.4	67.3	0	0
UBSD	30	132±13.1	71.6	54.2	2±15.3	0.13
URSD	30	128±12.7	69.5	54.4	−2±15.0	0.13
On average	90	130±8.0	75.7	58.2	×	×
Length of dry period (for higher lactation), days						
URD	30	63±2.5	13.9	21.9	−2±3.60	0.54
UBSD	30	62±5.5	30.1	48.0	−3±6.12	0.49
URSD	30	72±5.3	29.0	40.5	7±5.95	1.17
On average	90	65±2.7	25.5	38.7	×	×
Insemination index (for higher lactation)						
URD	30	6.52±0.798	4.37	67.0	0.01±0.89	0.01
UBSD	30	6.59±0.654	3.58	54.3	0.08±0.77	0.10
URSD	30	6.40±0.635	3.48	54.4	−0.11±0.75	0.15
On average	90	6.51±0.399	3.79	58.2	×	×
Calving period (for higher lactation), days						
URD	30	423±13.7	74.9	17.7	7±15.4	0.45
UBSD	30	420±14.3	78.6	18.7	4±15.9	0.25
URSD	30	406±8.3	45.2	11.1	−10±10.9	0.92
On average	90	416±7.1	67.6	16.2	×	×

Table 12. Inheritance of the main selection traits

Breed	n	Yield		Amount of milk fat	
		$r_p\pm s_r$	h^2	$r_p\pm s_r$	h^2
URD	30	0.45±0.14**	0.90	0.53±0.13***	1.06
UBSD	30	0.02±0.18	0.04	−0.03±0.18	0.06
URSD	30	0.24±0.17	0.48	0.29±0.17	0.58
On average	90	0.29±0.09**	0.58	0.32±0.09**	0.64

Since we have established a significant lengthening of the period from calving to fertile insemination (up to 132 days) and, accordingly, a significant increase in the insemination index, the lengthening of the period between calvings (from 406 to 423 days) is directly proportional to the increase in the overall performance of the industry, since this state of reproductive function does not provide for the production of one calf per year from a cow. A more detailed analysis of the inter-calving period revealed that the cows with the shortest service period and insemination index, respectively, also had the shortest period between calvings — 406 days. Among the other two breeds, no such natural trend was found. Thus, cows with the highest values of service-period and insemination index: UBSD, respectively, had a mediocre inter-calving period of 420 days compared to 423 days for their URD peers.

The experience of many countries with highly developed dairy farming and scientific forecasts of breeding scientists indicate that breeding work with the breed should be carried out on the principles of large-scale selection, which includes the intensive and centralised use of bulls-improvers using in-depth knowledge of the main methods of assessing the breeding qualities of animals, population genetics, patterns of variability and heritability of economically useful traits in populations and herds. Such an approach to breeding work will make it possible to increase the genetic progress in the population up to 60 kg of milk per cow per year [19]. For more than 40 years, the system of selection and breeding work in dairy cattle breeding has been based on the principles of large-scale selection: centralised evaluation, selection and intensive use of highly valuable sires on a breed-wide scale, creation of a semen bank for proven bulls, use of computers, methods of population genetics and other achievements of science and technology. Methods of computer modelling of selection and genetic processes in dairy cattle populations and genetic and economic optimisation of large-scale selection programmes have been developed [21, 30]. In the domestic and foreign literature, sufficient data have been obtained to date to show that all quantitative traits of livestock productivity obey the law of distribution of individuals, according to which about two-thirds of individuals in each population are characterised by indicators corresponding to the average value of the trait in this population. In the remaining individuals, this trait may be greater than the average value or less [28, 39]. The degree of inheritance of a trait to a certain extent determines the rate of genetic improvement of the population in which selection for this trait is carried out. Almost all economically useful traits of dairy and beef cattle are quantitative and have a sufficient degree of inheritance for effective selection, with the exception of fertility [26, 39]. Therefore, it is quite relevant to study the inheritance of the main selection traits in the context of new modern Ukrainian breeds in the conditions of the breeding farm. We estimated the following correlation coefficient between the main selection traits — milk yield and amount of milk fat between mothers and daughters (table 12).

Thus, low and medium positive correlations are observed between the milk yield of mothers and their daughters, up to 0.45. Moreover, the highest relative variability between the above traits is observed among URD cows — r_p=0.45 at the second level of reliability (P>0.99), which, accordingly, makes the maximum heritability coefficient — h^2=0.90. Average values of relative variability are observed in URSD cows — r_p=0.24 and h^2=0.48. And not high positive correlations are noted in UBSD cattle — 0.02 and 0.04, respectively. The assessment of the inheritance of milk fat has slightly different trends. The mother-daughter generation of the URD breed is characterised by a very high relative variability — 0.53%, which gives a very high inheritance coefficient h^2=1.06. The level of correlation of the amount of milk fat among URSD cattle is almost at the level of the previous trait — 0.29 and, accordingly, high h^2=0.58. But the correlation between the amount of milk fat of mothers and daughters among UBSD breeds changed its direction and became negative r_p= −0.03 with a low inheritance coefficient h^2=0.06.

The productivity of cows in most agricultural enterprises in terms of milk production is at an arbitrarily low level. One of the reasons for low milk yields is poor breeding practices. There is virtually no division of the herd into a breeding core, a production group and a reject. In such conditions, heifers are obtained without a purposeful purpose, where the best cows in terms of productivity are kept for reproduction [28, 39]. It has been established that there are individual animals with high productive potential in the cow herd. It is important to get descendants from them to reproduce the herd. The intensity of herd reproduction depends on the number of cows that are allocated to the breeding nucleus. Thus, an increase in the number of cows in the breeding nucleus leads to a decrease in the average milk yield in its group, and a decrease leads to an increase in the milk yield in the herd [4, 31, 33]. The number of first-calf cows raised depends on the culling of cows, therefore, herd reproduction and culling are closely linked. It is necessary to take into account the possibility of expanding the capacity of milk production enterprises [22]. The first stage of breeding work is to assess the productivity of cows, study the conditions of housing and feeding, identify cows with high genetic potential and preserve such cows to obtain replacement heifers, heifers and first-born cows. At the same time, it is important to establish the optimal number of cows in the breeding nucleus and its impact on increasing milk production [26, 28]. Therefore, the purpose of further research was to establish the effect of selecting cows for the first lactation in the breeding core of the herd, their breeding limit and productivity at different selection intensities. So, at a selection intensity of 15%, that is, the selection pressure is 85% or only five cows are included in the breeding nucleus, and their milk yield will increase compared to the average value by up to 22%. Consequently, the milk yield of these cows will be 7406 kg for the URD breed, while the average data for the herd is 5216 kg accordingly, the selection differential will be 2190 kg and the selection effect will be 1971 kg. Accordingly, the breeding limit or minimum milk yield of cows that will be selected for the breeding group will be 6686 kg (table 13). Among the UBSD cows, the average milk yield in the herd is 6210 kg. The productivity of the breeding core cows is 7512 kg, respectively *Sd*=1302 kg and *SE*=52 kg. Such a low selection effect is due to the low inheritance coefficient h^2=0.04. Due to the highest productivity of cows in the breeding group of this breed, the highest selection limit is also noted $\overline{X}_u$ =7084 kg. Although cattle of the URSD breed have the lowest breeding values ($\overline{X}_{bc}$=6755 kg, *Sd*=1781 kg, $\overline{X}_u$=6170 kg), they have a higher breeding effect than the previous group due to a higher level of heritability — *SE*=855 kg. At a selection intensity of 30%, the milk yield of the breeding core cows will increase to 19% among the studied breeds. The breeding differential with the increase of cows in the breeding nucleus significantly decreases. The selection of 30% of the best cows resulted in a selection differential of 1643 kg (URD), 977 kg (UBSD) and 1336 kg (URSD) of milk. At a selection intensity of 45%, the selection differential is: *Sd*=1243 kg, *Sd*=739 kg, *Sd*=1011 kg of milk, respectively. These data indicate the potential for increasing milk yields from a smaller number of cows in the breeding core.

The effect of breeding (selection) depends on the transmission of hereditary information to its offspring. Studies have shown that the coefficient of heritability in herds of URD, UBSD and URSD breeds, respectively, was h^2=0.9, h^2=0.04 and h^2= 0.48, therefore, of the above possible increase in milk yields with the intensity of selection of 30% will actually be manifested in the descendants of only 1479 kg, 39 kg and 641 kg and at a selection intensity of 45%, the selection effect will be 1119 kg 30 kg and 485 kg, respectively. As a result, depending on the intensity of selection, the selection limit will decrease (5991 kg, 6647 kg, 5572 kg and 5400 kg, 6319 kg, 5123 kg of milk yield, respectively).

Table 13. Modelling the effect of selection in cows of different breeds by milk yield, kg

Selection parameters	*n*	Breed		
		URD	UBSD	URSD
Intensity of selection – 15%				
$\overline{X}_{hr}$	30	5216	6210	4974
$\overline{X}_{bc}$	5	7406	7512	6755
Sd		2190	1302	1781
SE	5	1971	52	855
$\overline{X}_u$	5	6686	7084	6170
Intensity of selection – 30%				
$\overline{X}_{hr}$	30	5216	6210	4974
$\overline{X}_{bc}$	9	6859	7187	6310
Sd		1643	977	1336
SE	9	1479	39	641
$\overline{X}_u$	9	5951	6647	5572
Intensity of selection – 45%				
$\overline{X}_{hr}$	30	5216	6210	4974
$\overline{X}_{bc}$	13	6459	6949	5985
Sd		1243	739	1011
SE	13	1119	30	485
$\overline{X}_u$	13	5400	6319	5123

Table. 14. Modelling the effect of selection in cows of different breeds by the amount of of milk fat, kg

Selection parameters	*n*	Breed		
		URD	UBSD	URSD
Intensity of selection – 15%				
$\overline{X}_{hr}$	30	198	237	190
$\overline{X}_{bc}$	5	272	288	264
Sd		74	51	74
SE	5	78	3.1	43
$\overline{X}_u$	5	247	271	239
Intensity of selection – 30%				
$\overline{X}_{hr}$	30	198	237	190
$\overline{X}_{bc}$	9	253	275	245
Sd		55	38	55
SE	9	58	2.3	32
$\overline{X}_u$	9	223	254	215
Intensity of selection – 45%				
$\overline{X}_{hr}$	30	198	237	190
$\overline{X}_{bc}$	13	240	266	232
Sd		42	29	42
SE	13	44	1.74	24
$\overline{X}_u$	13	204	241	196

We also modelled the effect of selection on the amount of milk fat under the same conditions of intensive selection. Thus, at an intensity of selection of 15%, the productivity of cows in the breeding group will significantly increase — 272 kg (URD), 288 kg (UBSD) and 264 kg (URSD) of the breed (table 14). At a selection pressure of 70% or *i*=0.30%, respectively, the productivity of these animals will slightly decrease compared to the previous group to 253, 275, 245 kg, respectively, and at p=55% or *i*=45% to 240, 266, 232 kg, respectively. There is also a direct dependence of the selection differential on the selection pressure: 15%, so the theoretical increase in productivity will be at the level of 74, 51, 74 kg, respectively; at 30 — 55, 38, 55 kg and at 45% — 42, 49 and 42 kg, respectively. The actual increase in productivity is directly related to the inheritance coefficient h^2=1.06 (URD), h^2=0.06 (UBSD) and h^2=0.58 (URSD). The level of increase in actual productivity or the effect of selection was not unambiguous — 25, 2.3 and 32 kg (*i*=0.30%) and 44, 1.74, 24 kg (*i*=0.45%), respectively. Thus, a decrease in the number of cows in the breeding nucleus leads to a greater increase in milk yield and milk fat. Thus, with 15% of cows in the breeding nucleus, milk yields will increase to 42%, with 30% — to 31%, and with 45% — to 29%. The increase in the amount of milk fat, depending on the intensity of selection, is up to 39, 29 and 22%. In our opinion, from an economic point of view, it is more expedient to use moderate selection with its intensity of 30% or culling cows from the herd of 70%, which will increase productivity by 31 and 29%.

As a result of the research, a rather high hereditary potential of cows of modern Ukrainian breeds was established for the main signs of milk production.

Analysing the signs of dairy productivity represented by milk yield, content and amount of fat in milk, it should be noted that the highest indicators are characterised by cows of the Ukrainian Speckled dairy breed, which in the context of four lactations (6210–7593 kg of milk, 237–287 kg of milk fat) were better, except for the third one, where a clear leader in the main signs was not found.

In modern high-yielding herds, the duration of lactation (325–360 days), regardless of genotype (with or without Holstein bloodline), exceeds the optimal value (305 days), which is associated with later insemination of cows after calving and extended service period.

The milk yield reflex in cows of the studied breeds is within the limits of the accepted optimal values (1.81–2.02 kg/min), which indicates their good adaptability and adaptation to the technology of machine milking.

It was found that the live weight of animals of the three studied breeds at the end of the growing period is within the breed standards (287.9–326.1 kg), but the higher weight is distinguished by the peers of Ukrainian red (326.1 kg) and black speckled (325.7 kg) dairy breeds.

It was proved that there was no clear advantage in favour of a certain group of cows by the main measurements. Thus, the height at the withers (134 cm), depth (73 cm) and width of the chest (46 cm) are better developed in Ukrainian Black Speckled cattle, and the oblique length of the body (160 cm) and the girth of the metacarpal (19.9 cm) — in the red dairy breed, with a larger girth of the chest (206 cm) in the peers of the Red Speckled Dairy breed.

The analysis of the reproductive function of cows gives grounds to assert that among all studied breeds there is a significant deterioration of its function, this leads, regardless of genotype, to an increase in the duration of service period (128–132 days) and the period between calvings (406-423 days), and this negatively affects the yield of calves per year and, as a result, significantly increases the insemination index (6.40–6.59).

The analysis of correlations between the main selection traits of mothers and their daughters established high predictions regarding their inheritance (0.48–1.06), this will significantly increase the efficiency of selection for milk yield and milk fat in these herds of modern breeds.

Reducing the number of cows in the breeding nucleus leads to a greater increase in milk yield and milk fat. For example, with 15% of cows in the breeding nucleus, milk yields will increase to 42%, with 30% — to 31%, and with 45% — to 29%. The increase in the amount of milk fat, depending on the intensity of selection, is up to 39, 29 and 22%.

Based on our research, we recommend “Kolos 2011” LLC:

1. To conduct more precise selection and breeding work with cattle of the Ukrainian Red Speckled dairy breed by: using the parameters of relative variability and heritability in the assessment of trait development; applying cow selection to the breeding core with an intensity of 30%; continuing the practice of directed heifer rearing with constant monitoring of their live weight.

2. Since the level of reproductive function in the farm is problematic, which reduces the period of economic use of cows, reduces the level of their milk production, and at the same time the profitability of the industry as a whole, we recommend that the veterinarian and chief zootechnician develop both therapeutic and preventive measures to improve it, and introduce biotechnological methods of organising animal reproduction.

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Організація відтворення стада худоби молочного напрямку продуктивності

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Ми можемо говорити про достатньо високий спадковий потенціал корів сучасних українських порід за основними ознаками молочної продуктивності. Встановлено, що вищий надій, вміст та кількість жиру у молоці властиві коровам української чорно-рябої молочної породи, які у розрізі чотирьох оцінених лактацій виявлялися кращим, окрім лише третьої (де чіткого лідера за основними ознаками не виявлено). У сучасних високопродуктивних стадах худоби українських порід тривалість лактації, незалежно від генотипу з голштинською часткою кровності чи без неї, перевищує оптимальне значення (305 днів), що пов'язано із більш пізніми строками осіменіння корів після отелення та подовженою тривалістю сервіс-періоду. Тому, оцінюючи ефективність використання молочних корів, доцільно враховувати кількість дійних днів і відповідно до цього проводити корегування їх молочної продуктивності і відтворної здатності. А вплив голштинізації на подовження тривалості лактаційного періоду проявляється лише у стаді української чорно-рябої молочної породи. Рефлекс молоковіддачі у корів досліджених порід коливається в межах прийнятих оптимальних показників, що вказує на їх добру пристосованість та адаптацію до технології машинного доїння. Жива маса тварин трьох досліджених порід на кінець періоду вирощування залишається в межах стандартів порід, але вона вища в ровесниць червоної та чорно-рябої молочних порід, що вказує на їхню кращу здатність за відповідних умов вирощування до високої інтенсивності росту і, як показали попередні дослідження, до кращої молочної продуктивності. Ступінь розвитку основних промірів будови тіла корів перебуває в межах стандартів і відповідає нормам молочного типу корів, а чіткої переваги на користь певної групи корів за основними промірами не виявлено. Висота в холці, глибина та ширина грудей краще розвинені у представниць української чорно-рябої молочної худоби, а коса довжина тулуба та обхват п'ястка — в української червоної молочної породи, при більшому обхвату грудей у ровесниць української червоно-рябої молочної породи. Проведений аналіз відтворювальної функції корів дає підставу стверджувати, що серед усіх досліджених порід простежується значне її погіршення, що призводить, незалежно від породної належності, до подовження тривалості сервіс-періоду (128–132 дні) та періоду між отеленнями (406–423 дні); це негативно впливає на вихід телят за рік та як наслідок — значно підвищує індекс осіменіння (6,40–6,59). Аналіз кореляційних зв'язків між основними ознаками селекції матерів та їх дочок встановив високі прогнози щодо їх успадкування (0,48–1,06), що значно підвищить ефективність селекції за надоєм та кількістю молочного жиру в цих стадах сучасних порід.

Ключові слова: репродуктивна функція, статева охота, сервіс-період, індекс осіменіння, сухостійний період, штучне осіменіння, молочна продуктивність, порода

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