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# Variability of Indicators of the Exterior of Yaroslavl, Holstein Cows and their Hybrids

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*The research was conducted on the basis of JSC "Plemzavod Yaroslavka". The farm is engaged in the breeding of cattle of the Yaroslavl and Holstein breeds, as well as their crossbreeds with varying degrees of blood. All cows were measured during the third incomplete lactation. The height at the withers of the cows of the first group was 128.81±1.16 cm, the second – 145.69±1.07 cm, the third – 141.56±1.29 cm. The leadership in terms of variability goes to two indicators in all the studied groups: the udder furrow and the position of the udder bottom (76 and 67% in Yaroslavl purebred, 62 and 32% in Holstein purebred and 91 and 43% in crossbred animals. The lowest coefficient of variation in the indicators of height (4.2%), sacrum length (4.2%), pastern girth (4.1%), height at the withers (3.5%) in Yaroslavl cows; height (2.5%), height at the withers (3.2%) and oblique body length (3.4%) – in cows of the Holstein breed; width in macklocks (2.4%), sacrum length (2.5%) and height (2.6%) – in crossbred animals. In general, it should be noted that with large sizes of Holstein cows, their measurement variability is lower than that of Yaroslavl cows.*

**Keywords:** *exterior indicators, measurements, mean square deviation, coefficient of variation, cows.*

## Introduction

The features of the constitution are directly related to the longevity, fertility, health and performance of dairy cows and have been the object of direct genetic selection in various countries of the world for many decades. Biometric statistics in animal breeding is aimed at optimizing the process of breeding farm animals and selecting optimal conditions for their cultivation. When solving most breeding problems, one has to deal with multidimensional sets. Phenotypic variability is caused by various reasons (factors). In order to quantitatively assess their impact on animal productivity, it is necessary to decompose phenotypic variability into components.

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## Literature Review

Modern trends in dairy farming place ever higher demands on the adaptability of animals to intensive housing and exploitation technologies. Variability of exterior traits due to genetic and environmental factors requires constant monitoring and adjustment of breeding goals. The study allows us to identify the most stable and promising genotypes that can effectively adapt to changing conditions. Sheveleva O. M. and her assistant examined the exterior of Holstein cows and noted that the variability of exterior measurements in both young and full-grown cows exceeded 10% for individual traits alone. But at the same time, there are individual cows with significant deviations in the size of measurements, as evidenced by the value of the trait limits (Sheveleva, Moskaleva, 2022). T. T. Tarchokov and colleagues studied the exterior and constitutional features of cows depending on age and genotypes. The first (control) group included half-blooded first-calf cows obtained by crossing red steppe cattle with Angler breed sires (1/2KS+1/2A); the second (experimental) group included animals obtained by crossing cows of the 1/2KS+1/2A genotype with purebred Holstein sires of the red-and-white color of the first generation (1/4KS+1/4A+1/2G); the third (experimental) group included three-breed cows of the second generation (1/8KS+1/8A+3/4G). The groups of experimental animals were characterized by similar values of variability of body measurements. The coefficients of variation of body measurements fluctuated within 3.3–8.2% in the control group cows, within 2.9–8.9% in the 1st experimental group cows, and within 4.1–8.6% in the 2nd experimental group cows (Tarchokov et al., 2023). N. I. Tatarina, describing the use of exterior assessment in the selection of Holstein cattle, notes that the variability of index assessments, like measurements, is very low (the coefficient of variation fluctuated within 2.4–5.9% in the 2019 group of cows and 2.5–3.3% in cows in 2021) (Tatarina et al., 2023). Novoselova, K.S., examining the change in the exterior of cows in the agricultural production cooperative-agricultural association (collective farm) "Pervoe Maya" (892 heads, black-and-white Holsteinized), notes that the daughters of different breeding bulls had a very low variation coefficient in height - up to 2%, that is, they are very similar in general. The change in the trait of body depth in cows occurs insignificantly, with very low variation coefficients - from 2.2% (in the daughters of Spartak 3889) to 3.8% (in the daughters of Sayana 2237). The variability in the trait of "rump width" in the animals under study is also very low, and varies from 2.0% (daughters of Manita-M 438266333) to 6.8% (daughters of Lamori-M 470471). The indicators of mothers also have low values - 4.37% (Novoselova et al., 2021). Sheveleva O. M. in her other work, also devoted to the exterior of Holstein cows, also notes the low variability of the measurements presented on the slide. It should be noted that the coefficient of variation of the position of the bottom of the udder in full-grown cows is very high - 40.8%, which indicates a large number of animals that showed a very low position of the udder (below the hock joint by 7 cm or more). Some of the cows in the analyzed herd have an udder position above the hock joints by 17 cm or more. The coefficient of variation of the position of the front teats and the length of the teats is also high (Sheveleva et al., 2023). That is, the exterior indicators

of dairy cows have low variability, for most signs from 2.4 to 12.3%. The cows showed the greatest variability in the position of the bottom of the udder – up to 35%. From lactation to lactation, the variability of exterior indicators within one sample hardly changes.

The study of body measurements remains relevant and is used to predict live weight of animals (Gruber et al., 2018; de Oliveira et al., 2025). Scientists from Ethiopia studied the characteristics of different ecotypes of Shaka cattle (Masho et al., 2022). The results of Lu et al. (2021) could provide useful biological information for the improvement of body shape traits and contribute to the genomic selection of Chinese Holstein cows. Chinese scientists propose an approach to automated measurement and analysis of dairy cows using 3D point cloud technology (Lee et al., 2024; Ma et al., 2024). Recently, artificial intelligence technologies have been increasingly used in scientific research to analyze data (Xevelonakis & Mann, 2024). The issues of preserving biodiversity and the gene pool of local breeds are becoming extremely relevant (Jones, 2024).

## Materials and Methods

The aim of the work is to evaluate the variability of the exterior parameters of dairy cattle breeds. Objectives: to form samples of purebred Yaroslavl cows, purebred Holstein cows and their crossbreeds; to take the main zootechnical measurements; to analyze their variability; to establish the share of influence of the "breed" factor on the main measurements using variance analysis.

Research methods are general zootechnical: taking measurements, interpreting the obtained data, analyzing the information.

The object of the study was 38 live full-grown cows (the study sample), of which 16 heads belong to the Yaroslavl breed, 13 heads to the Holstein breed and 9 heads are their crossbreeds, with the Yaroslavl breed being the improved breed, and the Holstein breed improving. The selection of animals was carried out using the method of pairs-analogues by age and lactation stage. All animals were in the same feeding and housing conditions. Morphometry of cows was carried out by taking measurements in the 2nd-4th month of the third lactation. Animals were measured no earlier than 2 hours after milking on a level area with a concrete surface. Registration of exterior defects was carried out visually in accordance with the methodology of the "Rules for assessing the physique of daughters of dairy and beef bulls" (Moscow, 1996).

The hybrid index was calculated using formula (1):

$$H_J = [\frac{(Mh - Mf) \times 100}{Mm - Mf} \times 50] \times 2, \quad (1)$$

where Mh is the average value of the crossbreed trait, Mf is the average value of the trait of the improved breed (Yaroslavl), Mm is the average value of the trait of the improving breed (Holstein). Negative values of HJ indicate a deviation of the trait towards the Yaroslavl breed, positive ones – towards the Holstein, zero

means that the crossbreeds occupy an intermediate position between the original breeds.

Statistical processing of the obtained data was carried out using algorithms built into MS Excel. The standard deviation of the trait (σ), the coefficient of variation of the trait (Cv), the minimum (min) and maximum (max) values of the trait were studied as variability indicators.

## Results

Representatives of the Yaroslavl breed are mostly black. The exceptions are the head, lower legs and tip of the tail, belly and udder - they are colored white. Around the eyes are black markings in the form of "glasses". The horns (if the animal is not hornless) are white with black tips. The appearance of individuals with red, black and white, completely black, red and white colors is also acceptable.

The measurements obtained as a result of the research are presented in Table 1. For the completeness of the study, we compared these data with the average for the breed in order to find discrepancies in the key indicators of the measurements.

**Table 1.** *Exterior Characteristics of Yaroslavl Breed Cows*

| **Indicator** | **Average value for the animals studied, cm** | **Lim (min – max), cm** | **σ, cm** | **Cv, %** | **Average value for the breed** |
|---|---|---|---|---|---|
| Height | 136.4±1.47 | 126-153 | 5.90 | 4.34 | 139.0…143.0 |
| Height at withers | 128.8±1.16 | 120-137 | 4.64 | 3.60 | 125…127 |
| Oblique body length | 162.8±2.10 | 145-178 | 8.40 | 5.16 | 158.5…163.9 |
| Chest depth | 71.8±1.16 | 59-80 | 4.62 | 6.44 | 66…69 |
| Body depth | 79.7±1.12 | 73-86 | 4.34 | 5.44 | 74.0…75.5 |
| Rump length | 53.6±0.58 | 50-57 | 2.33 | 4.35 | 52.0…55.3 |
| Pelvic position | -14.69±1.04 | -23-(-6) | 4.16 | 28.32 | -8.2…-10.3 |
| Pelvic width | 15.1±0.70 | 12-20 | 2.79 | 18.54 | 31.3…33.5 |
| Width in hips | 52.1±0.55 | 49-58 | 2.14 | 4.12 | - |
| Length of front udder | 21.9±0.75 | 17-26 | 2.91 | 13.26 | 18.0…19.0 |
| Height of rear udder attachment | 23.7±0.92 | 19-30 | 3.57 | 15.08 | 24.0…26.2 |
| Udder width | 21.4±1.07 | 12-29 | 4.16 | 19.47 | 13.7…13.9 |
| Udder furrow | 2.2±0.44 | 0-7 | 1.72 | 78.68 | 2.7…3.8 |

| | | | | | |
|---|---|---|---|---|---|
| Position of udder bottom | 5.4±1.13 | -4-10 | 4.39 | 81.26 | 14.2…17.6 |
| Position of nipples | 19.6±1.30 | 11-31 | 5.05 | 25.79 | 16.1…18.8 |
| Length of nipples | 6.2±0.34 | 5-9 | 1.33 | 21.46 | 6.5…7.4 |
| Chest girth | 197.1±2.78 | 180-220 | 10.77 | 5.47 | 190.5…193.2 |
| Mescarpus girth | 17.8±0.19 | 17-19 | 0.75 | 4.21 | 17…18 |

From the table we see an abnormally small pelvic width and a low position of the udder bottom, compared to the average data for the breed. The remaining indicators are either within the norm or are at the limits of the norm. When analyzing the variability of the exterior indicators of Yaroslavl purebred cows by limits, it can be noted that the greatest spread is observed in the chest girth (40 cm), followed by the oblique length of the body (33 cm), height (27 cm), chest depth (21 cm), and the location of the nipples (20 cm). The average spread (from 11 to 17 cm) is observed in the indicators of height at the withers, pelvic position, udder width, udder bottom position, body depth, and the height of the attachment of the rear lobes of the udder, low (from 2 to 9 cm) - in the width at the hips, the length of the front lobes of the udder, the width of the pelvis, the length of the sacrum, the furrow of the udder, the length of the nipples and the girth of the metacarpus.

The analysis of the standard deviation of the measurements of Yaroslavl cows showed that the greatest variability is in the chest girth (10.77 cm) and oblique body length (8.40 cm). The following parameters have average variability values: height (5.90 cm), nipple position (5.05 cm), height at the withers (4.64 cm), chest depth (4.62 cm), udder width (4.16 cm) and udder bottom position (4.39 cm). Even less variability is in the length of the front lobes of the udder (2.91 cm), pelvic width (2.79 cm), rump length (2.33 cm), and hip width (2.14 cm). The smallest standard deviation is in the length of the nipples (1.33 cm) and metacarpal girth (0.75 cm). If we consider the variability by the variation coefficient, i.e. as a share of deviation from the average value, then the leadership goes to the indicators of the position of the udder bottom (81%) and the furrow of the udder (79%). Then, with a large gap, come the location of the nipples (26%) and the length of the nipples (21%), the width of the udder and the width of the pelvis (19% each). The smallest coefficient of variation is in the indicators of height (4.3%), the length of the sacrum (4.4%), the circumference of the metacarpus (4.2%), the height at the withers (3.6%).

Holstein cattle have a characteristic black and white color in the form of large varied spots, due to the presence of a dominant gene. Also in the breed there are animals of red and white color, which is a recessive form. Animals of red and white color are considered as breeding and are registered in a breed group. The main exterior indicators of Holstein cows are presented in Table 2.

**Table 2.** *Exterior Characteristics of Holstein Cows*

| Indicator | Average value for the animals studied, cm | Lim (min – max), cm | σ, cm | Cv, % | Average value for the breed |
|---|---|---|---|---|---|
| Height | 145.7±1.38 | 140…153 | 3.85 | 2.65 | 141.5…143.1 |
| Height at withers | 141.6±1.38 | 132…148 | 4.77 | 3.37 | 136.8…138.7 |
| Oblique body length | 169.8±1.72 | 160…182 | 5.95 | 3.50 | 165.5…168.6 |
| Chest depth | 77.4±1.40 | 74…93 | 4.85 | 6.26 | 74.6…76 |
| Body depth | 83.3±2.24 | 60…92 | 7.76 | 9.31 | - |
| Rump length | 56.1±0.88 | 52…61 | 3.04 | 5.42 | 51…51.8 |
| Pelvic position | -8.1±1.05 | -17…(-3) | 3.64 | 45.06- | - |
| Pelvic width | 20.5±0.61 | 18…25 | 2.11 | 10.29 | - |
| Width in hips | 55.5±1.16 | 50…65 | 4.03 | 7.27 | 50.4…52.3 |
| Length of front udder | 25.9±0.51 | 23…29 | 1.75 | 6.77 | - |
| Height of rear udder attachment | 24.8±0.61 | 22…28 | 2.12 | 8.51 | - |
| Udder width | 23.8±1.05 | 17…29 | 3.65 | 15.30 | - |
| Udder furrow | 3.8±0.72 | 1…10 | 2.48 | 64.43 | - |
| Position of udder bottom | 9.9±0.96 | 4…16 | 3.33 | 33.54 | - |
| Position of nipples | 15.0±1.29 | 9…21 | 4.45 | 29.69 | - |
| Length of nipples | 5.3±0.24 | 4…7 | 0.83 | 15.64 | 5.2…6.6 |
| Chest girth | 208.3±2.62 | 195…224 | 9.07 | 4.35 | 192.9…197.6 |
| Mescarpus girth | 19.3±0.29 | 18…21 | 1.01 | 5.24 | 18.6…19.1 |

It can be noted that, on average, Holstein cows at JSC Plemzoavd Yaroslavka exceed the average indicators for the breed in almost all respects.

Holstein cows have the greatest variation in such exterior indicators as chest depth (32 cm), followed by chest girth (29 cm) and oblique body length (22 cm). Average variation (from 12 to 19 cm) is observed in the following indicators: nipple position, udder bottom position, udder width, hip width, chest width, pelvic position, withers height, height, chest depth, low (from 3 to 9 cm) – in metacarpus girth, nipple length, udder furrow, posterior udder attachment height, udder anterior length, pelvic width and sacrum length.

The analysis of the standard deviation of the measurements of Holstein cows showed that the greatest variability is in the chest girth (9.07 cm) and oblique body length (5.95 cm). It should be noted that with the large size of Holstein

cows, the variability of their measurements is lower than that of Yaroslavl cows both in sigma and in the variation coefficient. Such indicators as height, nipple position, height at the withers, chest depth, udder width, udder bottom position, pelvic width, sacrum length and hip width have a sigma from 2.11 to 4.85 cm. The smallest standard deviation is in the length of the anterior udder lobes (1.75 cm), nipple length (0.83 cm) and metacarpus girth (1.01 cm).

If we consider the variability by the variation coefficient, then the leadership goes to the udder furrow (64%) and the position of the udder bottom (34%). There is no such gap, followed by the location of the nipples (30%) and the length of the nipples (16%), the width of the udder (15%) and the width of the pelvis (10%). The smallest variation coefficient is for the parameters height (2.7%), height at the withers (3.4%) and oblique body length (3.5%).

Crossbred animals have a dairy body type and a black-and-white coat. Its main advantages are high milk yields and unpretentiousness in care, taste and nutritional qualities of milk, resistance to diseases, especially leukemia. The main exterior indicators of crossbred animals are presented in Table 3.

**Table 3.** *Exterior Indicators of Crossbred Cows*

| **Indicator** | **Average value for the animals studied, cm** | **Lim (min – max), cm** | **σ, cm** | **Cv, %** | **Average value for the breed** |
|---|---|---|---|---|---|
| Height | 141.6±1.29 | 137-149 | 3.88 | 2.74 | 140.0…144.5 |
| Height at withers | 136.7±1.32 | 132-144 | 3.97 | 2.90 | - |
| Oblique body length | 174.4±2.25 | 162-183 | 6.75 | 3.87 | - |
| Chest depth | 77.1±1.09 | 70.5-81 | 3.26 | 4.24 | - |
| Body depth | 86.3±1.58 | 78-91 | 4.74 | 5.49 | 75.0…58.0 |
| Rump length | 55.6±0.50 | 53-58 | 1.50 | 2.69 | 55.4…58.0 |
| Pelvic position | -10.6±1.76 | -18-0 | 5.27 | 49.93 | -1.0…-2.6 |
| Pelvic width | 18.4±0.72 | 15-21 | 2.15 | 11.68 | 39.3…42.4 |
| Width in hips | 55.3±0.46 | 53-57.5 | 1.39 | 2.52 | - |
| Length of front udder | 22.7±1.19 | 11-17 | 3.57 | 15.75 | 21.7…24.1 |
| Height of rear udder attachment | 26.6±1.75 | 18-36 | 5.25 | 19.76 | 17.7…22.7 |
| Udder width | 21.2±1.15 | 17-28 | 3.46 | 16.29 | 20.1…22.6 |
| Udder furrow | 2.6±0.82 | 0-7 | 2.46 | 96.07 | 3.4…4.4 |
| Position of udder bottom | 9.9±1.49 | 3-16 | 4.48 | 45.35 | 16.4…19.7 |
| Position of nipples | 17.2±1.05 | 12-21 | 3.15 | 18.31 | 16.6…19.0 |
| Length of nipples | 6.2±0.29 | 5-7 | 0.87 | 14.04 | 6.0…6.3 |
| Chest girth | 209.1±2.43 | 195-217 | 7.30 | 3.49 | - |
| Mescarpus girth | 19.2±0.26 | 18-20.5 | 0.79 | 4.14 | - |

Crossbred cows do not have any indicators with a spread of 30 or 40 cm. The largest spread is for chest girth (22 cm) and oblique body length (21 cm). Ten indicators have an average spread (from 10 to 18 cm): height, height at withers, chest depth, body depth, pelvic position, chest width, length of the anterior udder, height of attachment of the posterior udder, udder width, and position of the bottom of the udder; six indicators have a low spread (from 2 to 9 cm): rump length, pelvic width, width at the hips, udder furrow, teat position, and teat length. If we consider the variability of crossbred cows by the standard deviation, it is as low as that of Holsteins. The indicator fluctuates in the range from 0.79 (metacarpus girth) to 6.75 cm (oblique body length), i.e. crossbred and Holstein cows are more aligned in exterior indicators than purebred Yaroslavl cows. But, if we consider the coefficient of variation, the variability of the udder furrow indicator of crossbred cows is the highest, even higher than that of purebred Yaroslavl cows - 96%. Also, the high coefficient of variation is for the indicators of pelvic position (50%) and udder bottom position (45%). Average variability according to the variation coefficient for the parameters of the height of the attachment of the posterior udder lobes, the length of the anterior udder lobes, the length of the teats and the width of the pelvis (from 12 to 20%), low for the parameters of height, height at the withers, oblique body length, chest depth, body depth, length of the sacrum, width at the hips, chest girth, and metacarpus girth (from 2.5 to 5.5%). Holstein cows had larger linear body measurements compared to Yaroslavl cows. Thus, in terms of height, they were superior by 9.3 cm or 6.4% ($p < 0.001$), in height at the withers by 12.8 cm or 9.0% ($p < 0.001$), in oblique body length by 7.0 cm or 4.3% ($p < 0.01$), in pelvic length by 2.5 cm or 4.7% ($p < 0.05$). Similar data on the superiority of Holstein cows were obtained from measurements characterizing body volumes such as chest depth (+5.6 cm, $p < 0.001$) and body (+3.6 cm), as well as chest girth (+11.2 cm, $p < 0.01$). This is probably due to the long-term selection of Holstein cows for milk productivity. Larger animals are able to consume and convert into products a larger amount of feed and, accordingly, produce more milk. Lower variability of exterior measurements in Holstein cows indicates long-term selection and elimination of individuals with extreme values.

Crossbred animals occupy an intermediate position in the above measurements, i.e. they inherited greater height, height at the withers, and chest depth from the Holstein breed. At the same time, in some measurements, such as oblique body length (+11.6 cm and +4.6 cm, respectively), chest girth (+12.0 cm +0.8 cm, respectively), body depth (+6.6 cm +3.0 cm, respectively), crossbreds surpass both the maternal and paternal breeds, thereby demonstrating the effect of heterosis.

When assessing the exterior, it is necessary to take into account the general development of the animal, its constitution type, breed, sex, age, physiological condition, production purpose and productivity level. Particular attention should be paid to defects and imperfections of the exterior, which can be both congenital and acquired.

Defects of the exterior are minor deviations from the norm in the structure of individual parts (articles) of the body.

Defects of the exterior are sharply expressed deviations from the correct structure of individual parts of the body, arising as a result of pathological changes in organs and tissues.

Defects and imperfections of certain articles are associated with a predisposition to certain diseases, productivity, deficiencies in animal feeding, with violations of animal husbandry technology, especially young animals. Sometimes defects of the exterior are the result of mutational variability. Common defects and imperfections of the exterior of farm animals include: improper structure and development of the head, neck, withers, back, loin and croup; narrow chest, chest interception behind the shoulder blades, improper structure of the abdomen, various defects and imperfections in the structure and position of the limbs (elephantiasis, O-shape, X-shape).

The elimination of defects and imperfections in the exterior of all farm animals is achieved by selection and selection of animals with a strong constitution for the reproduction of the herd and the targeted raising of young animals.

**Table 4.** *Exterior Defects of the Cows studied*

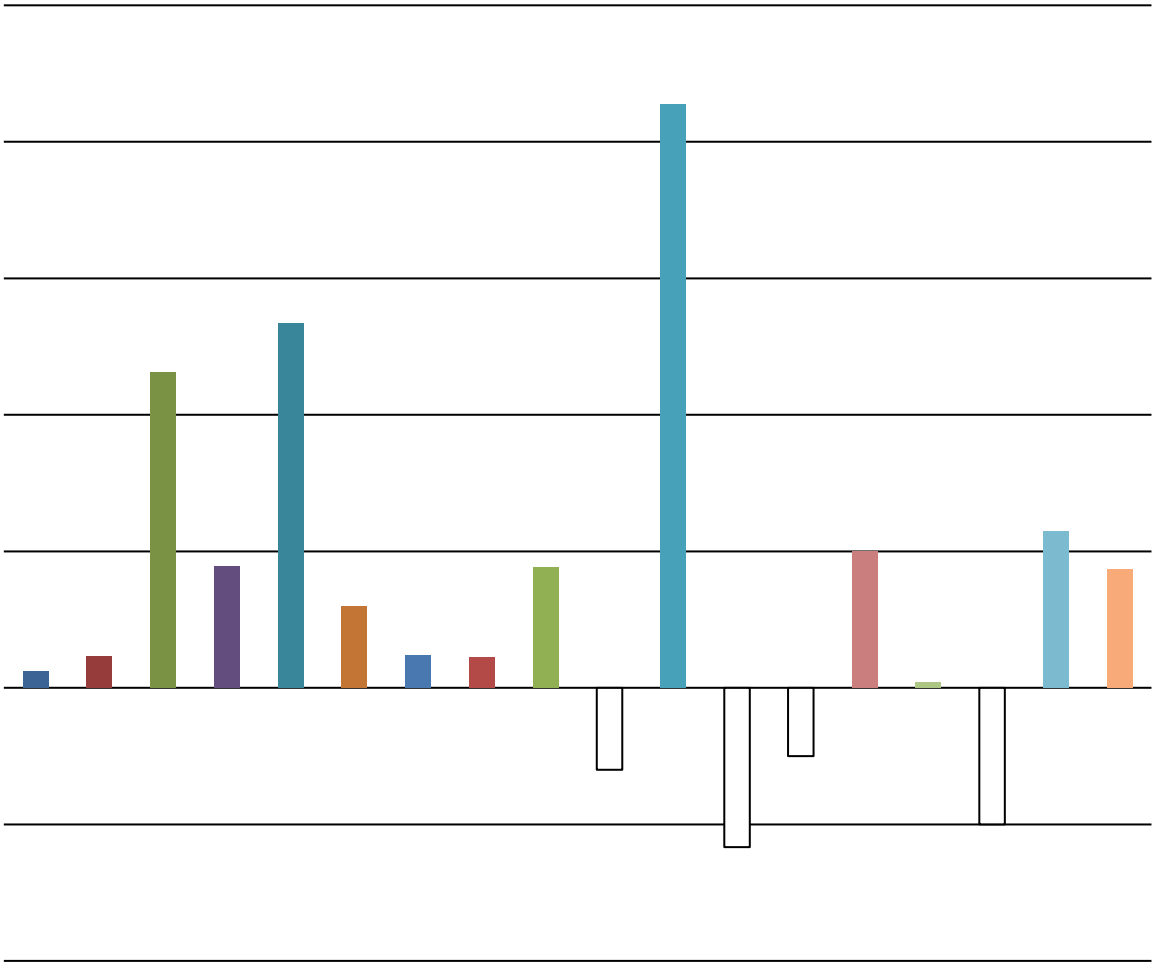
| **Fault** | **The number of heads with this defect in the Yaroslavl breed** | | **Number of heads of the Holstein breed with this defect** | | **Number of heads with this defect in crossbred animals** | |
|---|---|---|---|---|---|---|
| | **n** | **%** | **n** | **%** | **n** | **%** |
| Winged scapula | 1 | 6.25 | 1 | 7.69 | - | - |
| Roof-shaped sacrum | 16 | 100 | 3 | 23.08 | 6 | 66.67 |
| Teeths close together at the back | 2 | 12.5 | 5 | 38.46 | 1 | 11.11 |
| Weak pasterns | 10 | 62.5 | 1 | 7.69 | 5 | 55.56 |
| Tail root raised | 1 | 6.25 | 3 | 23.08 | 2 | 22.22 |
| Udder bottom slanted | 9 | 56.25 | - | - | - | - |
| Extra teats | 6 | 37.5 | - | - | 1 | 11.11 |
| Udder strongly divided (from sides) | 3 | 18.75 | - | - | - | - |
| Rear teats inclined | 1 | 6.25 | - | - | 1 | 11.11 |
| Thick teats | - | - | 1 | 7.69 | - | - |

In purebred Yaroslavl cows, 100% of the examined individuals have such a defect as "Winged scapula". In 62.5%, there is a defect called "Weak pasterns", 56.25% of animals have a slanted bottom of the udder and 37.5% have additional teats.

The main exterior defects of Holstein cows are - teats close together at the back, a roof-shaped sacrum and a raised root of the tail, they are present in 39%, 23% and 23% of cows, respectively.

In crossbred cows, we see the most common defects - a roof-shaped sacrum (66.7%) and "weak pasterns (55.6%). Based on this, we can assume that they were passed on to animals from the Yaroslavl breed. The crossbred cows have inherited the qualities of the Yaroslavl breed and also have an abnormally small pelvic width, a low position of the udder bottom and additionally the position of the pelvic bottom. Otherwise, the crossbred cows at the enterprise are within the norm.

**Figure 1.** *Hybrid Index of Measurements of the Yaroslavl Breed, Holstein and Crossbreeds*



The hybrid index is positive and the highest, i.e. it shows a strong closeness of the crossbreeds to the Holstein breed in such indicators as the height of the attachment of the rear lobes of the udder, the depth of the body, the oblique length of the body. The index is also positive, but has lower values for the following indicators: chest girth, position of the bottom of the udder, chest depth, width at the hips, pastern girth, length of the sacrum. The index has low values, i.e. the hybrid is intermediate in the indicators: position of the pelvis, height at the withers, width of the pelvis, height, position of the nipples. The index is negative, i.e. it shows the closeness of the crossbreeds to the Yaroslavl breed in

such indicators as the udder furrow, length of the front lobes of the udder, length of the nipples, width of the udder.

## Discussion

The formation of the exterior of animals, including body measurements, depends on heredity, while the process is also affected by the conditions of keeping and feeding. However, genetic factors play a key role, which is manifested in the differences in measurements and their variability in representatives of different breeds. As can be seen from the study, the greatest phenotypic variability in representatives of the three breeds was distinguished by udder measurements. The greatest variability in the degree of development of the central ligament (udder furrow) was found in crossbred animals (Cv = 96.07%), the least in Holstein cows (Cv = 64.43%), therefore this trait is not so much a breed feature as the influence of the father bulls. The variability of the "Position of the udder bottom" indicator in relation to the hock joint is high in Yaroslavl cows (Cv = 81.26%) and crossbreeds (Cv = 45.35%), while in Holsteins it has the lowest indicator (Cv = 33.54%). Undoubtedly, the use of Goshtinsky breed bulls on the Yaroslavl breeding stock led to an improvement in this indicator. According to measurements characterizing the growth of the animal in postnatal ontogenesis (oblique body length, chest depth, body depth, chest girth), the variability was low (Cv <10%) for all three groups. However, Yaroslavl cows have a high variability in growth, which indicates a certain heterogeneity of animals and insufficient selection for this trait. Similar results were obtained in the works of the authors Nasupov et al. (2021), Nikitivic J. et al. (2021, 2022), Slimene A. et al. (2020).

Registration of deficiencies also showed breed differences. The influx of Holstein blood had a positive effect on reducing and eliminating such deficiencies as a roof-shaped sacrum, sloping bottom of the udder, and additional teats. However, a number of new exterior deficiencies were added, less common in the Yaroslavl breed and more typical for Holsteins - these are close and sloping rear teats, which can negatively affect the connection of milking equipment. In crossbred animals, the deficiencies of weak pasterns are less often registered, this indicates that the strength of the constitution of these animals increases.

## Conclusions

If we consider the variability of the parameters by the standard deviation, then the parameters of chest girth and oblique body length have the greatest variability. In cows of the Holstein breed, the variability of measurements is lower than in cows of the Yaroslavl breed. Such parameters as height, nipple position, height at the withers, chest depth, udder width, udder bottom position, pelvic width, sacrum length and hip width have an average sigma. The smallest standard deviation is in the length of the anterior lobes of the udder, nipple length and metacarpus girth.

If we consider the variability by the variation coefficient, i.e. as a share of deviation from the average value, then the leadership goes to the parameters of udder furrow (62%) and udder bottom position (32%). There is no such gap, followed by nipple position (28%) and nipple length (15%), udder width (15%) and pelvic width (10%). The lowest coefficient of variation is in the parameters of height (2.5%), height at the withers (3.2%) and oblique body length (3.4%).

According to the hybrid index, the crossbred animals are closer to the Holstein breed in half of their measurements, to the Yaroslavl breed in 22%, and occupy an intermediate position in 28%, i.e. the Holstein breed had a stronger influence on the formation of the exterior parameters.

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