

## Conference Paper

# Phenotyping of Dairy Cattle in Breeding Programs

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**ORCID:**Irina Ivanova: <http://orcid.org/0000-0001-5700-9186>**Abstract**

This article examines the phenotypic features of cattle and their use in breeding to improve the characteristics of milk productivity. As part of the research, 483 black-and-white pedigree cows in the breeding enterprises of the Omsk region were evaluated by a set of characteristics. It was found that the average age of calving cows was 2.5 years. 42.7% in the total cow population were full-grown cows. The maximum level of milk productivity was observed in second lactation cows. The milk yield for 305 days of the second lactation was 6.720 kg, which was 621 kg or 9.24% higher than that in first-calf heifers. The phenotypic characterization of breeding stock allowed us to identify all the necessary reserves for obtaining high-yielding offspring, in order to increase the level of milk production in the black-and-white cattle population of the region. This research was conducted with the use of the technical base and laboratory areas of the Department of Animal Science (Faculty of Animal Science, Commodity Science and Standardization), as well as the Center for the Collective Use of Scientific Equipment of the Federal State Budgetary Educational Institution of Higher Education “Omsk State Agrarian University named after P.A. Stolypin”. The analytical data and the results of the research presented in this publication may be of interest for students of specialized educational institutions, as well as for specialists in dairy cattle farming, and can be implemented at breeding enterprises.

**Keywords:** Phenotyping, breeding, milk productivity, cattle

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## 1. Introduction

The organization of technological processes in modern animal husbandry is undergoing a transformation in the context of the developing Food Net program. The key segment of this market is the accelerated selection of animal breeds, as well as solutions that will speed up the breeding processes. Dairy farming is a comparatively slow industry in breeding programs, which is undoubtedly due to the relative late maturity of cattle and the long generation interval [1]. The need to provide consumers with high quality

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dairy products determines the search for measures that would increase the efficiency of dairy farming in modern economic conditions. The modern market sets tasks for the industry of creating conditions for stabilizing the livestock, increasing the volume of milk production and quality, raising the level of marketability of products and reducing production costs.

The effective use of highly productive animals in breeding programs contributes to the improvement of the genealogical structure of the breeding herd and the breed, to the accumulation of valuable genetic potential in subsequent generations, increases the probability of obtaining the animals with the highest breeding value [2]. Dairy cattle breeding programs are aimed at improving the hereditary gene pool through correctly planned choice and selection, as well as breeding methods, while simultaneously consolidating all the systems of organizational and economic production processes. Scientifically based long-term planning of breeding forms the basis of breeding programs in dairy farming, as it determines prospective trends in animal improvement [3-5]. The traditional black-and-white dairy cattle of domestic selection does not withstand competition with the best breeds of the world gene pool. The ways of using such cattle breeds as improving breeds for local livestock can be different, but they must be theoretically reasoned and practically tested. At present, a vast array of results of production activities to increase the abundant milk yield in Holsteins has been accumulated. In addition to the main breeding trait - abundant milk yield, selective breeding programs should be aimed at the combining high milk yield with the quality characteristics of milk. A thorough analysis of the selection results for a specific breeding stock is required; its adjustment for the use of the best compatibility of cows and sires is needed. Breeding programs in a herd of dairy cattle should provide the optimal choice and selection options to maintain a strong constitution type and desirable exterior forms in combination with high milk yield and milk quality, as well as satisfactory reproductive qualities of the breeding stock in real production conditions. Phenotyping or a complex individual assessment of animals by a complex of traits can be considered as the basis for breeding programs. When compiling breeding programs, scientifically based phenotyping of dairy cattle is relevant for producers. Thus, phenotyping of breeding stock and the use of the results in breeding programs is a promising direction for the development of pedigree dairy farming, which requires the informational methodological support for the assessment of animals and long-term planning of stockbreeding [6-8].

The issues relating to the organization of breeding processes in dairy farming and the assessment of the productive qualities of cattle (phenotyping) were covered in the

scientific works by Gridin V.F., Zhashuyev Z.Kh., Lefner T.F., Prokhorenko P.N. and other researchers [9-12].

Accurate determination of the potential of dairy cattle productivity is the main problem of breeders, as it directly affects the efficiency of the breeding process. Breeders are interested in determining the real potential of productive qualities as soon as possible, but milk production is due to the interaction of the animal's genotype and environmental conditions [13, 14]. In different growing and housing conditions, cattle will realize their productivity potential in different ways. Breeding enterprises' demand for high quality pedigree breeding stock determines the need for the quality phenotyping of dairy cattle. The planning of selective breeding work is able to assist the specialists of enterprises in organizing the breeding work and in achieving the set goal of stabilizing the level of high milk production in the herd. In numerous scientific works, it has been established that the results of assessing the productive qualities of cattle determine the main selection directions of the breed as a whole.

The subject of the scientific article is the characteristics of productive and exterior traits of the breeding stock of black-and-white cattle

The purpose of the work is to conduct phenotyping of breeding stock of dairy cattle and determine the main directions of breeding work with the herd

## 2. Methods and Equipment

The object of the research was the black-and-white livestock, 483 head, which are bred at the breeding enterprises of the Omsk region. Phenotyping was conducted according to the results of the complex traits assessment, which was carried out in line with the last complete lactation. Breed, class and age composition of the breeding stock was assessed. The productive qualities of cows were characterized by milk productivity (the milk yield in 305 days of lactation, kg; the mass fraction of milk fat, %; the amount of milk fat, kg). The involved animals were phenotyped by live weight and milk production coefficient. Exterior features were estimated by the linear assessment method with the formation of an exterior profile in accordance with deviations from the breed standard

## 3. Results

According to the results of the assessment of cows by a complex of traits, all the cattle breeding stock is purebred in the black-and-white breed. The data on breed and class composition are presented in Table 1.

TABLE 1: Breed and class composition of breeding stock

Animal group	Total, hd	including:					
		purebred and VI generation		class			
		hd	%	elite record		elite	
				hd	%	hd	%
Cows	483	483	100	483	100	-	-
Heifers	236	236	100	236	100	-	-
Heifers of all ages	173	173	100	173	100	-	-
Total	892	892	100.0	892	100.0	-	-

The analysis of breed and class composition of the breeding stock showed that all the cows in the population are purebred and are classified as elite record.

The average age of the cows is 2.5 calving. The proportion of full-grown cows is 42.7% (Figure 1).

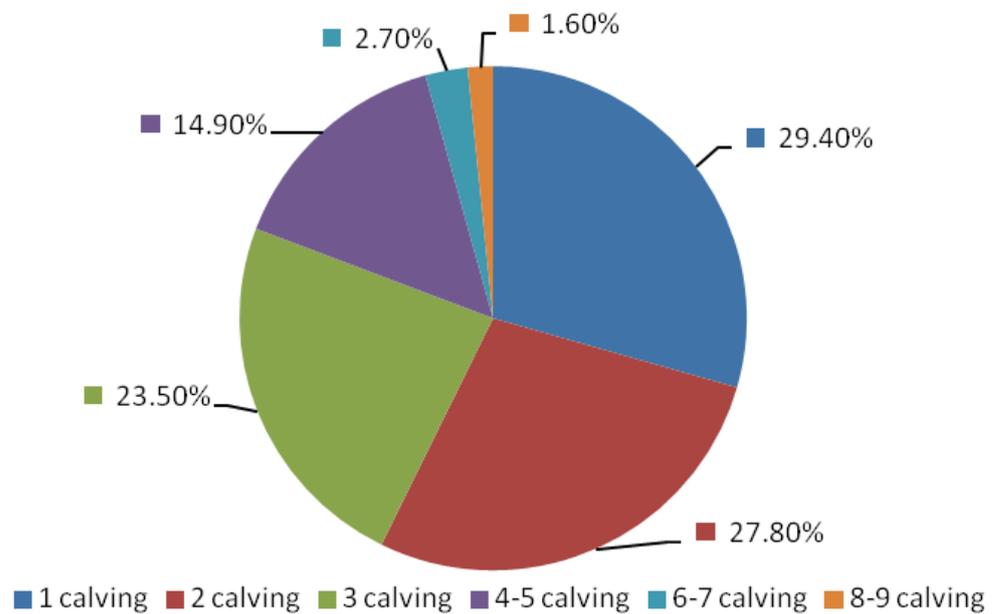


Figure 1: Age structure of the cows in the herd

It should be noted that the percentage of cows with more than 3 calvings is 19.2%, which is a good indicator, since this improves the conditions for breeding work with a dairy herd and helps to reduce the costs of its formation.

The results of evaluating the milk productivity show that the average milk yield for the study group of cattle is 6.411 kg of milk (Table 2).

The maximum level of milk productivity was observed in second lactation cows. The 305-day milk yield of second lactation cows was 6.720 kg, which is 621 kg or 9.24%

TABLE 2: Characteristics of cows by live weight and milk productivity for 305 days of the last complete lactation

Animal group	Milk yield, kg	Fat content		Live weight, kg
		%	kg	
1 lactation	6099	4.12	251.3	550
2 lactation	6720	4.17	280.2	563
3 lactation and more	6430	4.22	271.3	606
A total of cows with complete lactation	6411	4.17	267.3	572

higher than the milk yield in first-calf heifers. The high level of abundant milk production of second lactation cows is due to the correctly organized selection of cows based on the results of the previous lactation, since low-yielding first-calf heifers, according to the breeding program, must be rejected from the herd. The breeding program for the improvement of dairy cattle should provide for a simultaneous increase in abundant milk production and quality characteristics of milk. Thus, the amount of milk fat (in kg) can be considered as the main criterion for selecting the breeding stock. This indicator combines the quantitative and qualitative characteristics of the milk productivity of cows. The largest amount of milk fat (280.2 kg) was obtained from second lactation cows, although this group keeps an intermediate position in terms of the mass fraction of milk fat.

The milk production coefficient, which characterizes the dairy type of cows, shows how much milk the animals produce per 100 kg of live weight.

On average, the milk production coefficient for the studied breeding stock is 1.121 kg; this indicator is 1.109 kg for the first-calf heifers, which indicates the distinctive dairy type of cows.

According to the requirements for breeding enterprises (Rules in the field of livestock breeding “Types of organizations carrying out activities in the field of livestock breeding”, approved by the Order of the Ministry of Agriculture of Russia dated 17.11.2011 No. 431), the yield of milk fat and protein per cow must exceed the breed standard by 50%. Compliance of the indicators of the breeding stock with the requirements of the standard for the black-and-white breed is presented in Table 3.

As can be seen from Table 3, the level of productivity of black-and-white cows of all age groups exceeds the standard values for the breed by 164-200%, which meets the requirements for breeding enterprises.

Phenotyping animals involves the exterior assessment. The exterior traits of cows are of great importance in the development and implementation of breeding programs for improving dairy cattle productivity [15, 16]. The studied cattle population has a

TABLE 3: Compliance of the productive indicators of the breeding stock with the standard requirements for the black-and-white breed

Indicator	Actual value based on appraisal results	The minimum value of the indicator for the black-and-white breed	Percentage deviation of the actual value from the standard, %
Milk fat amount, kg			
1 lactation	251.3	129.0	194.8
2 lactation	280.2	140.0	200.1
3 lactation and more	271.3	155.0	175.0
Milk protein amount, kg			
1 lactation	193.3	105	184.1
2 lactation	213.0	114	186.8
3 lactation and more	206.4	126	163.8

characteristic color that is steadily transmitted to offspring, most often black-and-white, less often black with a different proportion of white marks on the head, lower belly, and legs.

The head of the cows is medium-sized, light-weight, the horns are not large, dark. The line of the back, loin and croup is straight, without deepening behind the shoulder blades [17]. The posterior part of the body is wide at the hips and ischial tubercles. The udder of cows is large and glandular. The area of attachment of the udder to the belly is adequate in most cows. Most cows have insufficient hoof horn strength. The results of the exterior assessment of cows by a complex of traits are presented in Table 4.

Thus, phenotyping by the exterior showed that cows are distinguished by the correct harmonious body conformation, a strong type of constitution with the marked dairy forms. To optimize the breeding process, it is necessary to take into account when selecting parental pairs the features of body conformation, namely the strength of the hoof horn, in order to reduce the frequency of this disadvantage in offspring.

TABLE 4: Assessment of the exterior of cows by a complex of traits

Traits taken into account	Assessment, points
1. Body volume	100
2. Dairy traits	100
3. Leg quality	95
4. Udder quality	97
5. General view	100

Thus, the characteristics of the breeding stock by phenotypic traits allow us to conclude that the studied livestock has all the necessary reserves for obtaining highly

productive offspring. According to the results of phenotyping, the best part of the animals, which can make up a selection group, was chosen. The selection group includes the best animals possessing a high degree of realization of the genetic potential for productivity and meeting the requirements of the breed standard. In breeding programs, it is necessary to develop a plan for the allocation of cows to a selection group in order to obtain high quality offspring in the required quantity. In the group of replacement heifers, it is necessary to select animals obtained from mothers of the second and subsequent calving, that is, from those that are phenotypically assessed.

The organization of breeding work should be based on the age structure of cows. The increase in the terms of use of breeding cows is essential for breeding enterprises, therefore, the correct raising of replacement heifers, the preparing of heifers for calving and the shearing of first-calf heifers should ensure a minimum culling of young cows for reasons of low productivity.

## 4. Discussion

The population of the studied cows is purebred. According to the results of a comprehensive assessment, it is classified as elite-record class.

## 5. Conclusion

Based on the studies and the subsequent analysis of the data obtained, it was found that the cows correspond phenotypically to the standard of the black-and-white breed. The level of milk productivity in cows of all age groups exceeds the standard values for the breed by 164-200%, which meets the requirements for breeding enterprises. The selection of cows for the selection group should be carried out taking into account the phenotyping of animals.

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The work was supported by the authors' own funds when performing an initiative scientific theme on phenotyping of cattle (Table 1). The proportion of cows at the age of 3 calving and older was 19.2%, as evidenced by Figure 1. The Table 2 data indicate an excess of milk yield in 305 days of lactation in the second lactation cows by 621 kg in comparison with the first-calf heifers. In comparison with the breed standard, the

level of milk production of cows exceeds the requirements of the breed standard by 164-200%, which is presented in Table 3.

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## Conflict of Interest

The authors have no conflict of interest to declare.

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