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Productive Traits and Reproductive Capacity of First-Calf Cows at Different Selection Options

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Abstract: The research work is aimed at determining and establishing the degree of influence of various selection options on the productive and reproductive qualities of the first-calf cows of the black-and-white breed. The research results showed that according to the Parental Index of Cows (PIC), animals of the 5th experimental group surpass their mates in the 2 and 3 groups in milk yield by 746 kg, with p≤0.05 and 1746 kg, with p≤0.001 and the difference in fat content is 0.07 and 0.01%, respectively. The same advantage in milk yield over the 3 experimental groups is possessed by the 1st control and the 4th experimental groups 1827 and 1885 kg, with p≤0.001. In terms of protein, group 3 cows are inferior to first-calf heifers of groups 1, 2, and 5 by 0.03, 0.08, and 0.09%, with a significant difference p≤0.01. Groups 1, 2, and 5 have superiority over animals of the 4th -0.03%, with p≤0.05, as well as 0.05 and 0.06%, with p≤0.01. The Realization of the Genetic Potential (RGP) in milk yield for 305 days of lactation was higher in the 5th experimental group and amounted to 88.3%, which is 7.1% more than in the control, with p≤0.05. For milk fat, animals of groups 1 and 3 have a high potential of 99.5 and 99.9%. In terms of the mass fraction of protein, first-calf heifers of the 1st control and the 4th experimental groups surpass their mates from group 3 by 2.1 and 1.8%, with p≤0.05. The control group has the most optimal indicator of the calving period (406.5), while the tested ones exceed it by more than 40 days. The service period in all groups has been increased by almost 2 times. The highest calf crop (92.3%) and reproduction rate (0.92%) are observed in the control group.

Keywords: Cow, First-Calf Cow, Milk, Selection, Productivity, Black and White Breed

Introduction

Determination of the level of genetic variability in the general phenotypic variability of linear parameters of the exterior in the dairy direction of cattle breeding is a priority in the evaluation of bulls (Chindaliyev *et al*., 2021).

Currently, the development of dairy cattle breeding is aimed at increasing the efficiency of milk production by improving the breeds, changing the number of animals in economic conditions, and using modern technologies and methods of breeding assessment (Abugaliyev *et al*., 2019; Baimukanov *et al*., 2021).

That is why high-productive herds are created, which should be resistant to various diseases and easily adapt to any changes in the conditions of keeping and feeding (Abugaliyev *et al*., 2021).

Holstein cows as a whole were characterized by a relatively strong constitution, a proportionally developed and slightly elongated body with average live weight, deep chests with well-defined milk veins, glandular and

properly attached bath-like, and cup-shaped udder, with an average intensity of milk yield (2.12-2.4 kg/min). The yield was for 1st lactation 6465.9-6951.2 kg, the 2nd lactation 7463.5-7706.2 kg, according the 3rd lactation 8254.2-8297.7 kg of milk (Semenov *et al*., 2021).

To increase dairy productivity, it is necessary to use the world's best gene pools (Bekenov *et al*., 2019; Chindaliyev *et al*., 2021).

One of the main tasks of zootechnic work is to obtain from animals as much as possible and relatively cheap high-quality products (Bekenov *et al*., 2020; Chindaliyev *et al*., 2019; Bekenov *et al*., 2019).

The productivity of animals and the quality of livestock products depends on their genetic characteristics (belonging to a particular breed, factory line, individual characteristics, heritability, etc.), gender, age, and physiological state of the organism, as well as on the influence of the external environment (nature of feeding, maintaining, keeping and use) (Shamshidin *et al*., 2021).

The category of first-calf heifers is an effective method of increasing dairy productivity, adjusting their intensity can fully realize the genetic potential and preserve the health of the animal, thereby extending the duration of the productive life (Kalimoldinova *et al*., 2019; Semenov *et al*., 2021; Yelemesov and Baimukanov, 2020).

Cattle grows and develops relatively slowly. Its life span is 18-20 years and the period of economic use of cows is 10-12 lactations since after 10 lactations their maintenance becomes unprofitable due to a decrease in milk yield and fertility (Konteh *et al*., 2017).

Earlier sexual maturity is characteristic of holsteinized replacement, in this regard, insemination can be carried out at an earlier age, which reduces the cost of their rearing (Lu *et al*., 2021; Holloway, 2005).

The breed advancement in practical breeding is carried out through the use of different methods of selection. Line breeding is the main method used in breeding farms. To ensure the development of promising lines and improve the breed through purebred breeding, it is necessary to use the best genetic material. The number of animals with valuable genetic traits increases in the herd by reproducing selected representatives of high-productive lines (Abugaliyev *et al*., 2021).

To increase the productivity of livestock, it is necessary to carry out large-scale selection based on the widespread use of genetic methods for assessing the breeding value of animals and the intensive exploitation of high-value breeding producers (Kratochvilova, 2001).

In addition, to increase the productivity of animals, one should provide them with properly prepared high-quality feed and appropriate keeping conditions (Abugaliev *et al*., 2021a).

In many farms, in selective breeding work with dairy herds of cattle, line breeding is widely used. The aim of this method is to preserve and enhance the valuable traits of the ancestors, and weaken their undesirable sides, that is, to approach the type of record-holders with the help of inbreeding and selection and not to obtain contrasting forms (Abugaliyev *et al*., 2019). To increase productivity, they often resort to interline crosses, that is, to mating animals belonging to different lines of the breed. At the same time, more viable animals are obtained, and the disadvantages of one or another line are eliminated (Baimukanov *et al*., 2021).

In modern dairy cattle breeding, the main task of zootechnical science and practice is the further intensification of the industry aimed at increasing the genetic potential of productive qualities of domestic breeds of animals and the degree of its realization (Shamshidin *et al*., 2021).

The development of molecular biology, population genetics, biotechnology, the development and implementation of large-scale breeding, and the use of computer programs for the analysis of breeding information have enriched the arsenal of tools for the study of biological patterns and management of animal heredity, breed-forming processes (Konteh *et al*., 2017).

The theoretical basis of modern breeding is population genetics, based on the combinative variability of traits and knowledge of the patterns of their inheritance.

Predicting the effect of breeding by modeling them with an accurate calculation of the average for cows of the same age in the entire breed is a priority (Abugaliev *et al*., 2021b).

A promising alternative in the existing system of evaluation of breeding value is the genomic breeding program, which solves a wider range of issues, starting with the mothers of bulls, the type, and volume of evaluation of bulls, their use based on the results of the evaluation of genomic breeding value. The economic efficiency and advantages of using genomic breeding are based on the fact that the genomic breeding value can be calculated for calves at a very early age. If we compare genomic selection and traditional breeding, in terms of the reliability of the quality of offspring, it is almost as reliable, but faster due to the shorter interval between generations. Genomic selection can not only save costs, and accelerate genetic progress by 50%, but also increase breeding pressure (Zaton-Dobrowolska *et al*., 2007).

In world practice, index evaluation is used using information systems that allow getting an objective idea of individual animals and herds as a whole (Chindaliyev *et al*., 2021).

Thus, the expressed priority is to increase the economic efficiency of production and improve its quality characteristics by improving the breeding qualities of animals and the rational use of genetic resources.

Aim of the Research

The aim of our study was to determine and establish the degree of impact of different selection options on the

productive and reproductive traits of first-calf cows of the black-and-white breed.

The Novelty of Research

For the first time, the Parental Cow Index (RIC) and the Realization of the Genetic Potential (RGP) for milk yield for 305 days of lactation were determined, showing the genetic capabilities of the animal and the degree of transmission of productive qualities to offspring, as well as the degree of realization of the genetic potential of the dairy productivity of maternal ancestors.

Materials and Methods

Scientific and economic research was done in Lenin Plemzavod LLC of Koverninsky district of the Nizhny Novgorod region and at the department of private zootechnics, rearing of agricultural animals and obstetrics, Nizhny Novgorod State agricultural academy. The animals were divided into groups depending on the combinations of selection with subsequent biometric processing of the primary research material. 5 groups of first-calf cows of the black-and-white breed were formed. The first control group included animals obtained from pure lines, where both the paternal and maternal ancestors belong to the same line (n = 30). The second group included cows, where the paternal ancestors are of one lineage and the maternal ancestors are of another line (n = 8). The third group included cows where the paternal ancestors are from the pure line and the maternal ancestors belong to the cross of lines (n = 14). The fourth group included animals where the paternal ancestors belonged to the cross of lines and the maternal ancestors belonged to one pure line (n = 20). The fifth group included cows with crossed paternal and maternal ancestors (n = 27).

The breeding value of dairy cattle is determined based on the collection of data on productive indicators (milk yield, milk fat content, protein, and the number of somatic cells), as well as the results of a linear assessment of the exterior of animals by calculating this aggregate information.

Digital materials were processed by the method of variation statistics (Baimukanov *et al*., 2021).

Results and Discussion

The results of the studies showed the influence of origin on the dairy productivity of cows (Table 1).

Cows of the first group had a milk yield for 305 days of lactation of 8233 kg, live weight of 517 kg, milk yield rate of 2.24 kg/min. Cows had the following indicators, respectively: In the second group 8357 kg, 519 kg and 2.25 kg/min; the third 8198 kg, 512 kg, 2.25 kg/min; the fourth 8440 kg, 512 kg, 2.25 kg/min; the fifth 7904 kg, 519 kg, 2.27 kg/min.

It was found that first-calf heifers of the 4th experimental group surpass their mates of the 5th group in terms of milk yield by 536 kg of milk per lactation, at p≤0.01, but they are inferior in terms of the fat content in milk by 0.08% and the protein content 0.02% belonging to the cross of lines according to their paternal and maternal ancestors.

The mass fraction of fat in milk was the largest in the fifth group (3.98%) in comparison with the other groups from the first to the fourth (3.90-3.94%). In the studied groups of cows, the mass fraction of protein in milk was in the range of 3.11-3.13%. Milk yield for 100 days of lactation in all groups exceeded 3000 kg and amounted to 3034-3257 kg.

The genetic potential of animals is one of the most important factors determining livestock value. It is based on information on the productivity of maternal ancestors, contained in the breeding cards. For the formed 5 groups, the Parental Index of Cows (PIC) was determined, showing the genetic capabilities of the animal and the degree of transmission of productive qualities to the offspring, as well as the degree of realization of the genetic potential of the dairy productivity of maternal ancestors (Table 2).

The parent index of cows was: According to milk yield from 8303-10344 kg; the mass fraction of fat in milk is 3.96-3.99%; the mass fraction of protein is 3.12-3.21%.

The realization of the genetic potential was: By milk yield 84.0-88.3%; by the mass fraction of fat 98.2-99.9%; by the mass fraction of protein is 96.4-98.5%.

The research results showed that according to the Parental Index of Cows (PIC), animals of the 5th experimental group surpass their mates in the 2 and 3 groups in milk yield by 746 kg, with p≤0,05 and 1746 kg, with p≤0.001 and the difference in fat content is 0.07 and 0.01%, respectively.

Table 1: Productivity of first-calf heifers with different selection options

Groups	n	Productivity for 305 days of lactation			Milk yield for 100 days, kg	Live weight, kg	Milk transfer rate, kg/min
		Milk yeild, кг	Fat, %	Protein, %			
		$\bar{X} \pm m_8$	$\bar{X} \pm m_8$	$\bar{X} \pm m_8$	$\bar{X} \pm m_8$	$\bar{X} \pm m_8$	$\bar{X} \pm m_8$
1	30	8233±150	3.92±0.02	3.12±0.01	3161±65	517±2.15	2.24±0.01
2	8	8357±295	3.91±0.03	3.12±0.45	3257±133	519±3.73	2.25±0.03
3	14	8198±168	3.94±0.05	3.12±0.01	3034±84	512±2.41	2.25±0.03
4	20	8440±150**	3.90±0.03	3.11±0.01	3125±63	512±2.72	2.25±0.02
5	27	7904±99	3.98±0.03	3.13±0.01	3030±54	519±3.41	2.27±0.02

Note: Here and after* p≤0.05; ** p≤0.01; *** p≤0.001

Table 2: PIC and RGP Indicators of maternal ancestors of first-calf heifers

	PIC			RGP		
Groups	According to milk yield,	According to fat, %	According to protein, %	According to milk yield,	According to fat, %	According to protein, %
1	10130±139***	3.94±0.02	3.17±0.01*.**	84.1±2.46	99.5±0.79	98.5±0.33*
2	9598±63	3.92±0.03	3.20±0.01**	86.2±1.96	98.8±0.93	97.6±0.73
3	8303±185	3.98±0.03	3.12±0.02	84.0±1.68	99.9±1.44	96.4±0.73
4	10188±170***	3.96±0.04	3.15±0.01	85.2±2.37	98.2±1.49	98.2±0.45*
5	10344±187*.***	3.99±0.03	3.21±0.02**	88.3±2.23*	98.9±1.56	98.0±0.74

The same advantage in milk yield over the 3 experimental groups is possessed by the 1st control and the 4th experimental groups 1827 and 1885 kg, with $p \geq 0.999$. In terms of protein, group 3 cows are inferior to first-calf heifers of groups 1, 2, and 5 by 0.03, 0.08, and 0.09%, with a significant difference of $p \leq 0.01$. Groups 1, 2, and 5 have superiority over animals of the 4th 0.03%, with $p \leq 0.05$, as well as 0.05 and 0.06%, with $p \leq 0.01$.

The Realization of the Genetic Potential (RGP) in milk yield for 305 days of lactation was higher in the 5th experimental group and amounted to 88.3%, which is 7.1% more than in the control, with $p \leq 0.05$. For milk fat, animals of groups 1 and 3 have a high potential of 99.5 and 99.9%. In terms of the mass fraction of protein, first-calf heifers of the 1st control and the 4th experimental groups surpass their mates from group 3 by 2.1 and 1.8%, with $p \leq 0.05$.

Regular annual calving provides a physiological stimulus for subsequent lactation, and the resulting offspring gives to conduct an expanded reproduction of the herd, which makes it possible to increase the level of profitability of the livestock industry (Abugaliev and Bupebayeva, 2022).

It was found that black-and-white cows realize their genetic potential at a high level, which is facilitated by the use of prepotent sires.

The pharmaceutical market offers a wide range of various products, many of which are of chemical origin, the bioavailability of which is low (Grigoryevich *et al*., 2020).

The reproductive capacity of cows is an important component of a comprehensive livestock assessment. To control and assess the reproductive ability of cows, it is more convenient to use the indicator of the duration of the service period, since it is determined earlier than the calving interval and dry periods. From the point of view of herd reproduction, the most important indicator is the age of the first insemination of animals. It indicates the level of farming as a whole since early coverage of heifers is possible only when the animals reach the optimal live weight.

It should be noted that the first insemination of animals is carried out at 15.0-16.1 months. It is not a bad indicator, but currently, the most optimal age for the first insemination is 18 months when the animals reach the required live weight.

The reproductive traits of animals do not meet the standards for all groups, which is a consequence of the intensive use of cows. A significant increase in the duration of the calving period was revealed for all groups of animals, which occurred as a result of an extension in the service period.

During lactation, milk productivity varies within 5000...14,850 kg, which determines the genetic potential of cows of the formed groups (Abugaliyev *et al*., 2018).

The analysis of the results obtained for the aggregate estimation period showed that when using information for two adjacent years, firstly, the number of daughters per one estimated bull increases (to 52.4%), and secondly, the average number of effective daughters increases (up to 51.5%) per one tested bull and thirdly, the average number of effects of HYS factors increases (up to 43.1%), per one servicing bull (Zheksembekovich *et al*., 2020). In particular, black-and-white cattle are capable of producing 4936-6761 kg of milk, with a mass fraction of 3.80-3.96% fat in milk and 3.28-3.40% protein (Zhumanov *et al*., 2022).

The control group has the most optimal indicator of the calving period (406.5), while the tested ones exceed it by more than 40 days. The service period in all groups has been increased by almost 2 times. The highest calf crop (92.3%) and reproduction rate (0.92%) are observed in the control group (Table 3).

Thus, the results of studies of the reproductive abilities of cows with different combinations of selection indicate the advisability of using intralinear selection (paternal and maternal ancestors belong to the same line).

The main task for selecting the right genotypes is to assess the breeding value of animals that can contribute to increasing the genetic potential of the next generation. Determination of the breeding value of dairy cattle is the main criterion for increasing the genetic potential of animals and their productive indicators.

Private indexes are within the limit of 100, so we studied the CPI, having previously divided them into groups. The results of this study are presented in Table 4.

The results of the studies showed that cows of the first, second, and fourth groups have a high milk yield for 305 days of lactation. The best indicators of the breeding value index were shown by cows of the fourth group, in comparison with other groups.

The first heifers of the fourth experimental group (8440 kg) have high milk productivity, the mass fraction of fat is animals of the third (3.94%) and fifth groups (3.98%), and the mass fraction of protein of the peers of the fifth group (3.13%) (Table 5).

The amount of milk with a base fat content of 3.4% is high in cows of the fourth group (9681 kg) and the smallest in the fifth group (9252 kg). The amount of milk of basic fat content (3.4%) was obtained in the first group of 9492 kg, in the second group of 9611 kg, and in the third group of 9500 kg.

Table 3: Reproductive capacity of first-calf cows

	Groups				
Indicators	1	2	3	4	5
Age of the first fruitful insemination, months	15.50±00.24	15.60±00.35	15.30±00.36	16.10±00.52	15.00±0.27
Service period, days	128.80±09.99	146.50±12.83	174.40±33.80	155.40±24.01	163.90±8.15
Calving period, days	406.50±10.24	426.10±13.36	448.10±32.14	433.50±24.27	441.80±8.30
Calf crop, %	92.30±02.15	86.30±02.64	85.70±04.50	88.60±04.00	83.30±1.44
Reproduction rate, %	0.92±00.02	0.86±00.03	0.86±00.04	0.89±00.04	0.83±0.01

Table 4: Distribution of the General Index of breeding value (IBV) by class interval

	Groups				
Indicators	1	2	3	4	5
General IBV (lim)	723-103.2	78.5-109.4	84.7-103.2	84.7-109.4	78.5-103,2
Milk yield in 305 days, kg	8561±171.0	8458±19600	8318±174.00	8790±155.00	8143±115000
IBV of milk yield for 305 days, kg	106.9±1.8	105.9±0.90	108.4±0.50	107.3±0.70	100.0±0.80
IBV of milk yield for 305 days, kg	100.1±0.3	100.6±0.10	100.2±0.20	100.2±0.20	99.9±0.20
IBV protein in 305 day**s**	99.9±0.2	100.0±0.10	99,8±0.2.00	100,2±0.1000	96,6±0.4000
Milk productivity index	100.8±0.1	107.3±0.20	100.5±0.20	108.7±0.30	105.3±0.30
Udder Health Index	100.8±0.1	100.5±0.20	100.3±0.10	100.2±0.20	100.1±0.20

Table 5: Efficiency of milk production

	Groups				
Indicators	1	2	3	4	5
Milk yield per forage cow, kg	8233.00	8357.00	8198.00	8440.00	7904.00
Fat content, %	3.92	3.91	3.94	3.90	3.98
Protein content, %	3.12	3.12	3.12	3.11	3.13
The amount of basic fat content (3.4%), kg	9492.00	9611.00	9500.00	9681.00	9252.00
Selling price, rub/kg	25.00	25.00	25.00	25.00	25.00
Sales proceeds, rub.	237300.00	240275.00	237500.00	242025.00	231300.00
± to 1 control group	0.00	+2975.00	+200.00	+4725.00	-6000.00

Analyzing the economic efficiency of milk production in Lenin Plemzavod LLC, it should be noted that the second (+2975 to the first group), the third (+200 to the first group), and the fourth (+4725 to 1 group) experimental groups give good income to the farm, but the greatest sale proceeds of the product are obtained from animals of the fourth experimental group, where the paternal ancestors belong to the cross lines and the maternal ancestors belong to the same pure line (Table 5).

Discussion

Cows of black-and-white breed in the conditions of LLC Lenin Plemzavod realize their genetic potential at a high level. The Realization of the Genetic Potential (RGP) in milk yield is higher in the fifth experimental group (88.3%), which is 7.1% more than in the control group, with $P \leq 0.05$. For milk fat, animals of the first and third groups have a high potential of -99.5 and 99.9%. In terms of the protein mass fraction, the first-calf heifers of the control and the fourth experimental groups surpass the peers of the third group by 2.1 and 1.8%, with $p \geq 0.95$. The first fruitful insemination of cows is carried out at the age of 15.0-16.1 months. The reproductive traits of animals are unsatisfactory. The Duration of the Calving Period (DCP) is increased. The control group (406.5) has the optimal DCP indicator, while the tested ones exceed it by more than 40 days. The control group has the highest calf crop (92.3%) and reproduction rate (0.92%).

Conclusion

Based on the obtained data, it can be concluded that the dairy products of the control group did not surpass the experimental ones in terms of their indicators. First-calf heifers of the fourth experimental group exceed their mates of the fifth group in milk yield by 536 kg of milk, at $p \leq 0.01$, but are inferior in fat content by 0.08% and protein content 0.02% and maternal ancestors to cross lines.

The largest sale proceeds of the product in Lenin Plemzavod LLC "is obtained from animals of the fourth experimental group (+4725 to group 1), where the paternal ancestors belong to the cross of lines and the maternal ancestors belong to the same pure line. Breeding of the fifth experimental group of cows is unprofitable.

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Author's Contributions

Anuarbek Temirbekovich, **Bissembayev:** The author of the idea, head of the event, generalization, 20%.

Dastanbek Asylbekovich Baimukanov: Responsible executor, preparation of the manuscript, 20%.

Orest Antipovich Bassonov: Performer, analysed of research results in 20%.

Kharon Adievich Amerkhanov: Share of implementation and contribution to the preparation of the article 20%.

Oleg Yurievich Petrov and Nadezhda Nikolaevna Kuzmina: Conducted experimental research, 10%.

Ethics

All the principles of scientific ethics have been observed during the research work, there is no conflict of interest.

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