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Влияние степени инбридинга на эффективность производства молока

РЕЗЮМЕ

Уральский тип отечественной черно-пестрой породы отличается высокими показателями продуктивности, хорошей пригодностью к использованию в условиях промышленной технологии молока, но длительность его продуктивного долголетия составляет 2,4–2,6 лактации, хотя в стадах имеется поголовье коров с продолжительность использования до 10 лактаций. Снижение продуктивного долголетия связано, в частности, с воспроизводительными качествами. В результате проведенных исследований установлено, что наиболее устойчивыми к длительному использованию в условиях молочных комплексов промышленного производства молока племенных репродукторов оказались коровы линии Силинг Трайджун Рокита, продолжительность продуктивного периода у которых оказалась 4,0 лактации. В других линиях она колебалась от 1,8 (линия Пабст Говернера) до 2,5 (линия Монтвик Чифтейна) лактаций. Низкий коэффициент воспроизводительной способности (менее 0,95) указывает на имеющиеся проблемы с воспроизводством в стаде. Современный голштинизированный черно-пестрый скот, разводимый в Свердловской области, обладает высокими племенными качествами. Потенциал их использования достаточно высок и, несмотря на определенные проблемы с воспроизводством, эти животные могут длительное время продуктировать в эколого-кормовых условиях зоны разведения.

Ключевые слова: корова, молоко, продуктивность, удой, лактация, голштинизированная черно-пестрая, порода

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Influence of inbreeding degree on the milk yield efficiency

ABSTRACT

The Ural type of the domestic Black-and-White mottled breed of cattle features high rates of milk productivity, good suitability for industrial milking technology, but the productive longevity is 2.4–2.6 lactations only, although in the herds there are livestock of cows with a productive longevity up to 10 lactations. The decline in productive longevity is associated with deterioration of reproductive qualities of the cows. In result of the research it was found that the most resistant to long-term use in conditions of dairy complexes for industrial milk production in pedigree reproducing farms were the cows of the Siling Trajun Rokita line. Their productive period was 4.0 lactations. In other lines, the productive longevity ranged from 1.8 (Pabst Governor's line) to 2.5 (Montvik Chieftain's line) lactations. A low fertility rate (less than 0.95) indicates the presence of reproduction problems in the herd. The modern Holsteinized black-and-white mottled cattle, bred in Sverdlovsk region, possess high breeding qualities. The potential of their use is quite high and, despite certain problems with reproduction system, they can produce for a long time in the environmental and forage conditions of the breeding zone.

Key words: cow, milk, productivity, milk yield, lactation, Holsteinized black-and-white breed

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Введение / Introduction

The food safety of the country is the most important task for people engaged in the country's agro-industrial complex [1–3]. At the same time, great importance is referred to the development of dairy farming, from where milk and beef — the valuable food products — are obtained. For milk production breeds of highly productive dairy cows of domestic and foreign selection are used [4–6].

These breeds include the Black-and-White mottled breed of cattle, which accounts for more than 51% of the total cattle population in the country. The second place is represented by Holstein breed of cattle, which proportion is more than 15% and is constantly increasing. This breed is related kind of breed; and its genetic pool has been used to improve domestic Black-and-White mottled cattle in the last four decades. Long-term use of crossing Black-and-Whitemottled cattle with Holstein cattle led to creation of a large array of Holsteinized black-and-white mottled cattle variable in genotypic and phenotypic characteristics depending on the breeding region with certain climatic, environmental and forage conditions [7–9].

In Sverdlovsk region the Ural type of Holsteinized black-and-white mottled cattle was officially registered in 2002. It is distinguished by a high proportion of genetic traits of the Holstein breed, which is constantly increasing and reaches 97 and more percent in some separate herds. It features good milk yield, suitability for machine milking in industrial complexes, but has a low duration of productive longevity and reduced reproductive functions. In addition, in herds there is a large share of cows born as a result of closely related mating.

The general aggregate index of milk production efficiency is the rate of return and the level of profitability. Getting profit in market conditions is the main goal of entrepreneurship and a criterion for production efficiency.

Labor productivity, quality of the final product, its material consumption and capital investment intensity are the main components of production efficiency. In conditions of hard competition in production efficiency assessment, the importance of competitiveness increases, which is determined by a number of parameters, where the price and quality of products occupy a special place. The general aggregate index of production efficiency is the rate of return and the level of profitability. Profit in market conditions is the main goal of entrepreneurship and a criterion for production efficiency. Among the other many indicators of profitability the following ones must be given attention: 1) product profitability, which is determined by ratio of net profit to product cost; 2) the profitability of production, which is determined by ratio of net profit to the value of fixed assets or to the cost of the enterprise's capital.

In agricultural enterprises the efficiency of production, in our case — milk production, depends on the productivity of cows, production costs and purchase prices for the products [10, 11]. Evaluation of the efficiency of using cows, depending on the factors affecting their productive qualities, is relevant and of practical importance.

The aim of the work is to assess the productive qualities of cows of unrelated origin that belong to different genotypes.

The research was run in one of the breeding farms of Sverdlovsk region. To do the research, we used the data from the "Selex" program database, that contains data on zootechnical and pedigree registration. Milk yield was assessed by control milking once a month; MFF and MFP were monthly determined in a control sample of milk from each cow using a milk tester. The amount of milk fat and milk protein was calculated according to generally accepted formulas.

The aim of the work is to evaluate the efficiency of using the cows born according to various breeding methods (i.e. degree of inbreeding) for milk production.

The research was run in one of the breeding farms of Sverdlovsk region, engaged in breeding of Holsteinized Black-and-White mottled cattle of the Ural type. For the analysis we used the data of zootechnical and breeding records of the "Selex" database. To calculate the efficiency of milk production, all production costs were taken into account. The efficiency was calculated according to the methodology of the Department of Economics of the Moscow Agricultural Academy named after K.A. Timiryazev, 1989.

In Sverdlovsk region, Holsteinized black-and-white mottled cattle of the Ural type, officially registered in 2002, are used for milk production [12, 13]. This type of cattle was created as a result of long-term improvement of the Black-and-White mottled breed of Ural offspring by its crossing with the world's best gene pool — the Holstein dairy breed. Currently the cattle is bred both "within their community" and also by further adding of Holstein cattle. For this, the semen of the best servicing Holstein bulls of foreign selection is purchased. Long holsteinization provided the positive results, it created the highly productive herds of Black-and-White dairy cattle, but it also increased the level of inbreeding [14–17]. In herds of some dairy farms in the region the number of cows born from closely related inbreeding achieved 85 and more percent of the total number of cows.

The milk yield of first lactation for cows with different degrees of inbreeding was different (refer to the table 1).

The table shows that the increase of inbreeding degree was accompanied by the milk yield per lactation. Thus, with close inbreeding, milk yield amounted to 8455.7 kg, which is more than average by 777.0 and 1309.1 kg, or by 9.2–15.5%, respectively, in reference to inbreeding degrees. The difference in milk yield between groups of cows with different levels of inbreeding was significant at $p \leq 0.05–0.01$ in favor of cows with close inbreeding. The

Table 1. **Milk yield of cows depending on the degree of inbreeding**

Parameter	Degree of inbreeding		
	close	moderate	remote
Milk yield per lactation, kg	8455.7±44.95	7678.7±40.66*	7146.6±59.32**
MFF, %	3.99±0.003	3.97±0.002*	3.95±0.003
Amount of milk fat, kg	348.59±1.90	303.20±1.54**	282.73±2.36**
Protein, %	3.20±0.002	3.19±0.001*	3.18±0.002*
The amount of milk protein, kg	279.31±1.54	243.64±1.24**	228.04±1.91**
Live weight, kg	580.5±0.55	580.3±0.42	581.5±0.64
Milk yielding factor	1456.6±81.73	1323.2±96.81	1229.0±92.69*
Amount of nutrients per lactation (fat + protein), kg	627.9±3.44	546.84±2.78**	510.77±4.27**
Received nutrients per 100 kg of live weight, kg	108.2±1.00	94.2±0.62	87.8±0.67

Note: * $p \leq 0.05$; ** $p \leq 0.01$

Table 2. **Milk production efficiency**

Parameter	Degree of inbreeding			On average
	close	moderate	remote	
Milk yield, kg	8456	7679	7147	7760
Milk yield in terms of basic fat and protein, kg	9471	8565	7939	8659
Cost of 1 kg of milk, rub.	18.9	20.8	22.4	20.6
Selling price of 1 kg of milk, rub.	23.0	23.0	23.0	23.0
Total cost, rub.	159 856	159 856	159 856	159 856
Received from the sale, rub.	217 833	196 995	182597	199 157
Profit +, –, rub.	57 977	37 139	22 741	39 301
Profitability level, %	36.3	23.2	14.2	24.6

milk of cows in the same group featured an increased content of MFF and MFP in their milk. The difference is significant at $p \leq 0.05$ in favor of cows obtained with close inbreeding. High milk yield and higher content of MFF and MFP led to a higher yield of nutrients with milk per lactation ($p \leq 0.01$), including per 100 kg of live weight.

The milk yield coefficient is used to judge the constitutional orientation of cows toward one or another direction of their productivity. The results of calculating the milk yield coefficient showed that all cows were of the dairy type and had this indicator over 1000 kg.

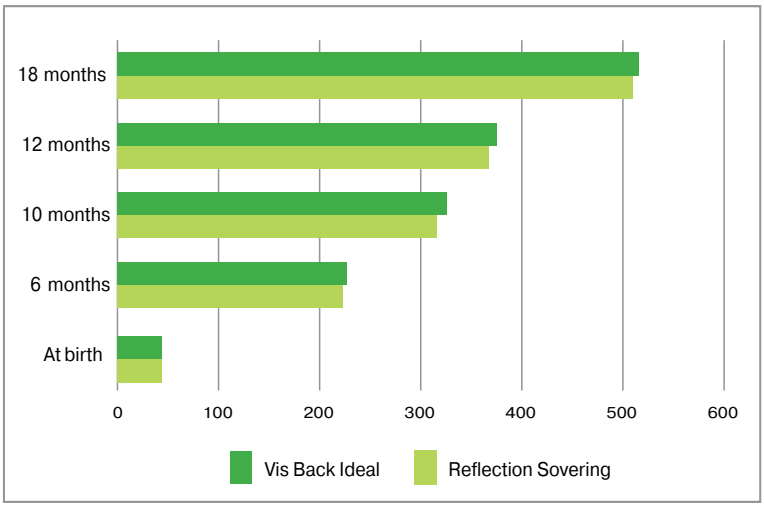
The efficiency of milk production, along with other factors, depends on the milk yield per lactation and the quality indicators of milk (table 2).

The level of milk profitability on the farm is quite high and averages 24.6% with fluctuations depending on cows' degree of inbreeding from 14.2% (remote) to 36.3% (close). This is determined, as already mentioned, by the milk yield per lactation and the quality of milk (MFF and MFP in milk). Since these values were higher in closely inbred cows, the level of profitability in this group turned out to be the highest.

Thus, we can conclude that inbreeding in Holsteinized Black-and-White mottled cattle of the Ural type allows getting cows with high milk productivity, and their use in milk production shows a high level of profitability. The best cows were born from the close degree of inbreeding.

The aim of the work was to study the relationship between growth indicators by periods in replacement heifers of different lines.

Figure 1. Dynamics of live weight gain among the replacement heifers by growth periods, kg



Материал и методы исследования / Materials and method

The replacement heifers of Holsteinized black-and-white mottled cattle served as the objects of research. The research was run on the pedigree reproducing farms engaged in breeding of Holsteinized Black-and-White mottled cattle of the Ural type of Sverdlovsk region. All cows, that finished lactation, were included in the research.

The data of zootechnical and veterinary records of the IAS "SELEX. Dairy Cattle" database were used. The data of live weight gain of replacement heifers obtained by monthly weighing. Average daily body weight gains and correlation coefficients between body weight were calculated for the periods of growth. The cows were divided into groups depending on their linear origin: group 1 consisted of replacement heifers of the Vis Back Ideal line; group 2 was represented by cows of the Reflection Sovering line.

Результаты и обсуждение / Results and discussion

The increase in the breeding value of the herd is ensured by the introduction of more and more best breeding young cows into it. Perhaps this is directed selection and breeding work on selection, selection; obtaining and intensive rearing of young cows with high genetic potential of milk production. The results of growing the replacement young livestock on the farm, depending on their linear origin, are presented below in figure 1.

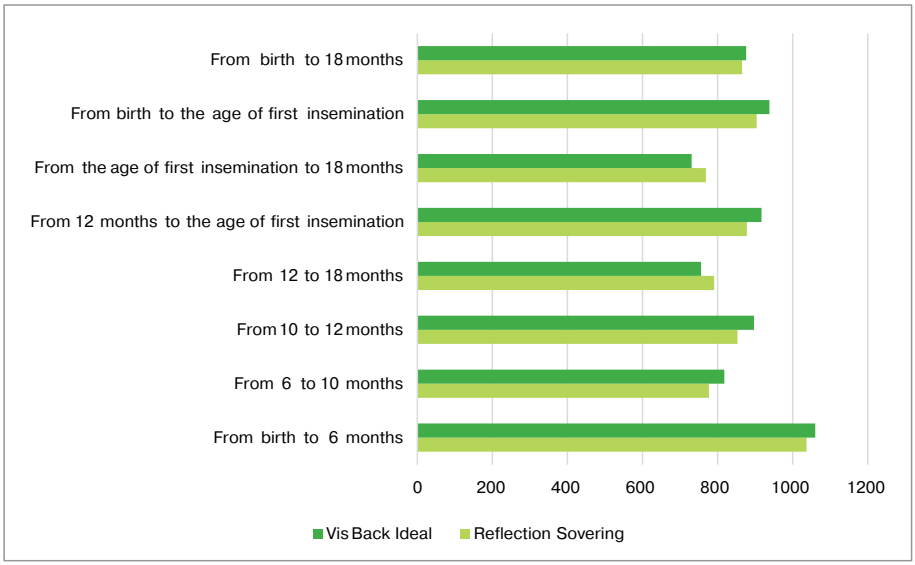
The figure obviously shows that heifers of the Vis Back Ideal 1013415 line in live weight in all periods surpass their peers from the Reflection Sovering 198998 line, despite the fact that they all were raised in the same conditions of caring and feeding, and at birth had almost the same live weight. At the age of 6, 10 and 12 months the difference in live weight was significant at $p \leq 0.05–0.01$ in favor of heifers from the Vis Back Ideal 1013415 line.

According to the average daily gains in live weight, it is possible to track the growth rate of heifers in various periods of growing. In addition, according to the dynamics of average daily gains, it is possible to assess the system of fattening the young livestock. Figure 2 shows data on average daily gain in live weight among the replacement heifers of Holstein lines of black-and-white mottled cattle.

The highest average daily live weight gains were recorded in the heifers during the lactation period. The farm runs an intensive system of young livestock raising with average daily gains of 900–950 g up to the first insemination, and with high average daily gains during the dairy rearing period. This allows for super-early insemination of replacement heifers at the age of 12.8–13.2 months when the live weight reaches 300–401 kg respectively by the breed lines.

The interrelation of the researched traits, mentioned above, with each other is of interest. While studying it, we found that in

Figure 2. Average daily gains in live weight of replacement heifers, g



of heifers from the Reflection Sovering 198998 line.

Thus, from the above it can be concluded that the farm was running an intensive system of raising the young livestock and inseminated the heifers at a very early period (up to 14 months) when their body weight was 399–405 kg. According to the periods of growth, a positive correlation of changes in live weight was recorded. The correlation between body weight by periods and the age of the first insemination was negative.

The ratio of cows by line is shown in the diagram (figure 5).

heifers of the Reflection Sovering 198998 line this interrelation is medium and high positive in terms of growth periods, with the exception of correlation of live weight at birth and at 18 months of age (figure 3).

The correlation coefficient between body weight at birth and the live weight at 18 months was –0.04. The similar calculations were run using the data of Vis Back Ideal 1013415 line (figure 4). As a result of the assessment of correlation of the live weight of replacement heifers from Vis Back Ideal 1013415 line, the low negative correlation was found between the live weight at birth and at the age of 10 and 12 months. In other periods, the relationship is high and positive. Correlation coefficients were calculated between the values of live weight by various periods and the live weight at age of the first insemination. As a result, it was found that there is an average negative correlation between these values among the replacement heifers of the studied lines.

The figure 4 obviously shows that only in the case of assessing the correlation between body weight at birth and the age of first insemination in heifers of the Vis Back Ideal 1013415 line, the correlation coefficient was 0.10. The correlation between body weight at the first insemination and the age of the first insemination was also positive. The correlation was negligible little, but still higher in the group

Figure 3. Correlation of live weight of replacement heifers from Reflection Sovering 198998 line by growth periods

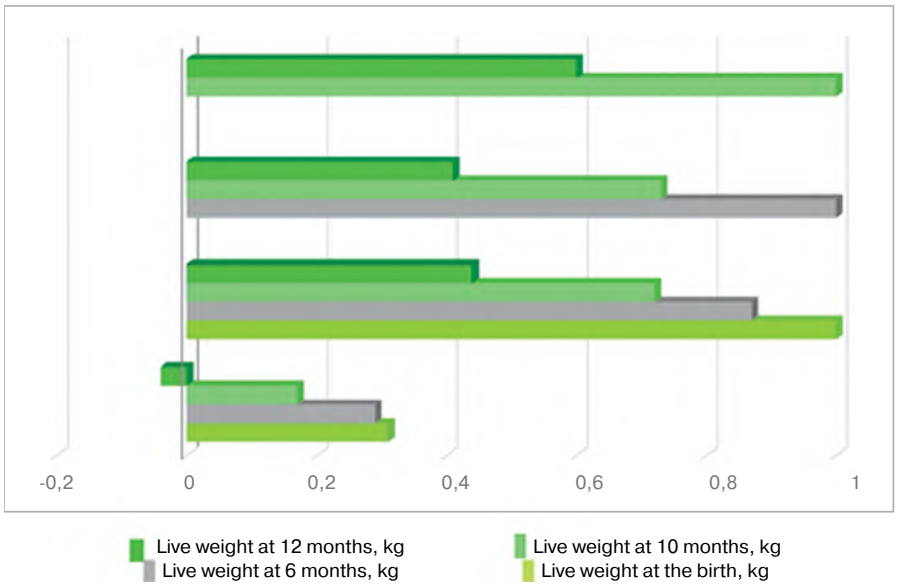
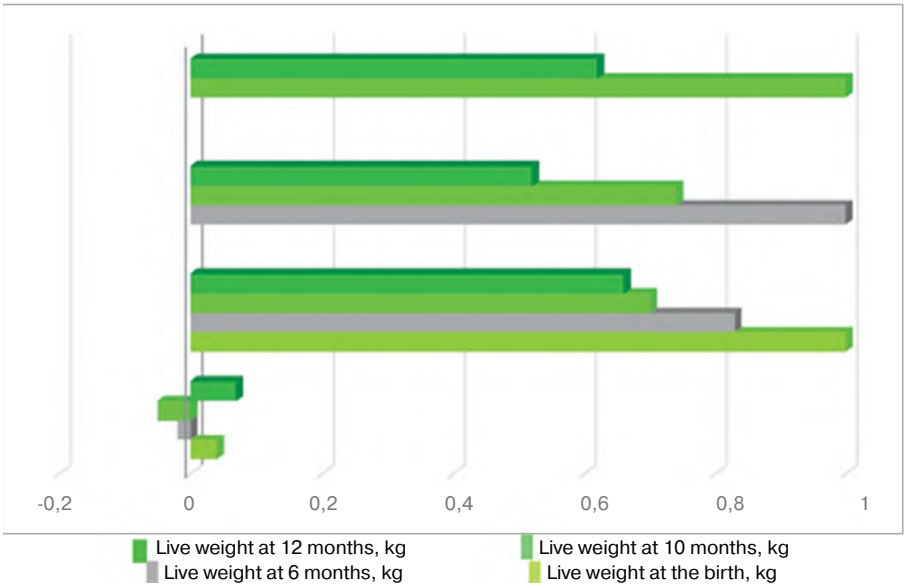


Figure 4. Correlation of live weight of replacement heifers of the Vis Back Ideal 1013415 line by growth periods



The figure above clearly shows that in breeding reproducing farms, the cows of two lines — Vis Back Ideal and Reflection Sovering — are used in greater numbers — 52.3 and 29.9%, respectively. So, 9.0 and 8.4% are represented by cows of the Siling Trijun Rokita and Montvik Chieftain lines. Cows of the Pabst Governor line occupied only 0.4%. Each line contains cows of different ages. Data on the percentage of cows depending on age in lactation is presented in the figure 6.

The ratio of cows' shares of different ages depends on their belonging to one or another line, which is clearly seen in the figure. The cows of the Siling Trajun Rokita line proved to be the most resistant to long-term use in the technological conditions of dairy complexes and the most fit for the industrial milking; their productive longevity was 4.0 lactations. In other lines, the productive longevity ranged from 1.8 (Pabst Governor's line) to 2.5 (Montvik Chieftain's line) lactations.

Figure 5. The ratio of cows of different lines in the breeding reproducing farms of Sverdlovsk region

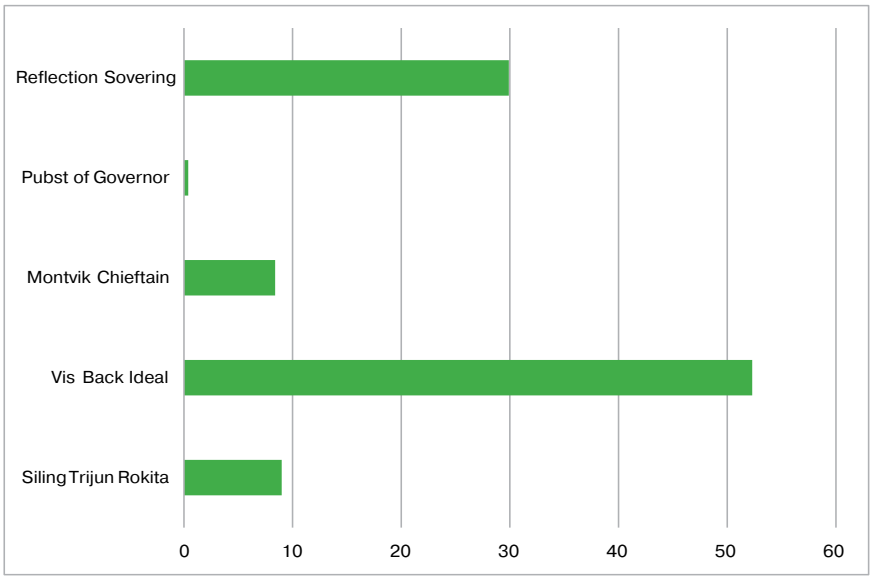
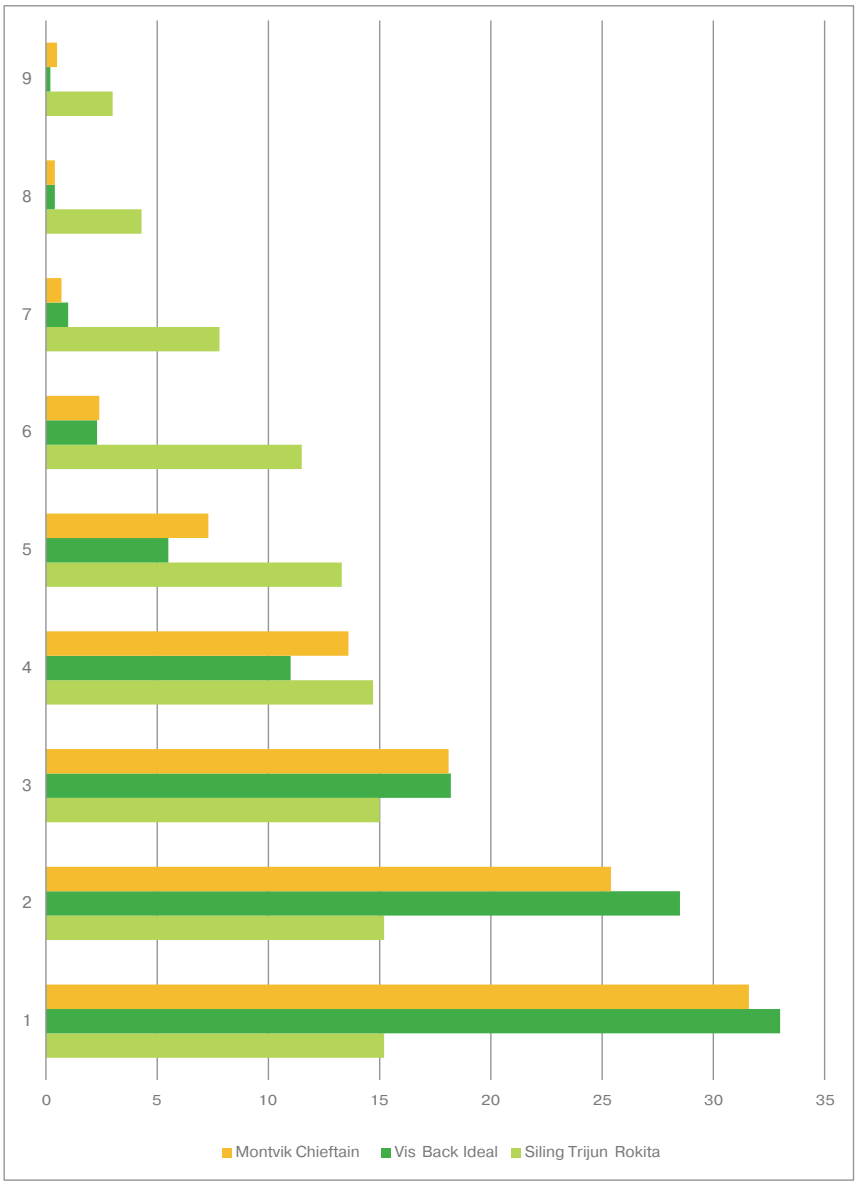


Figure 6. Line structure by number of cows in lactations,%



The dynamics of cows' milk yield by lactation is of interest to assess their ability to sustain steady productive qualities with age and the correlation of production duration with productive qualities (figure 7).

The figure above clearly shows that the cows of the first three lines have a general pattern of increasing milk yield to mature lactation. The cows of the Pubst Governor line showed the highest productivity for the 9th lactation, which is most likely associated with a small number of cows and their selection for milk yield and duration of lactation. However, it can be noted that they increase milk yield for a longer time (up to 4–5th lactation), but it is lower than that of cows of other lines. The Reflection Sovering cows had the best milk yield at the 2nd lactation. Further, in all lines, stable milk yields were observed with a slight decrease relative to mature cows for the 3–4th lactation with minor fluctuations towards decrease or increase, which is explained by rejection of low-productive cows.

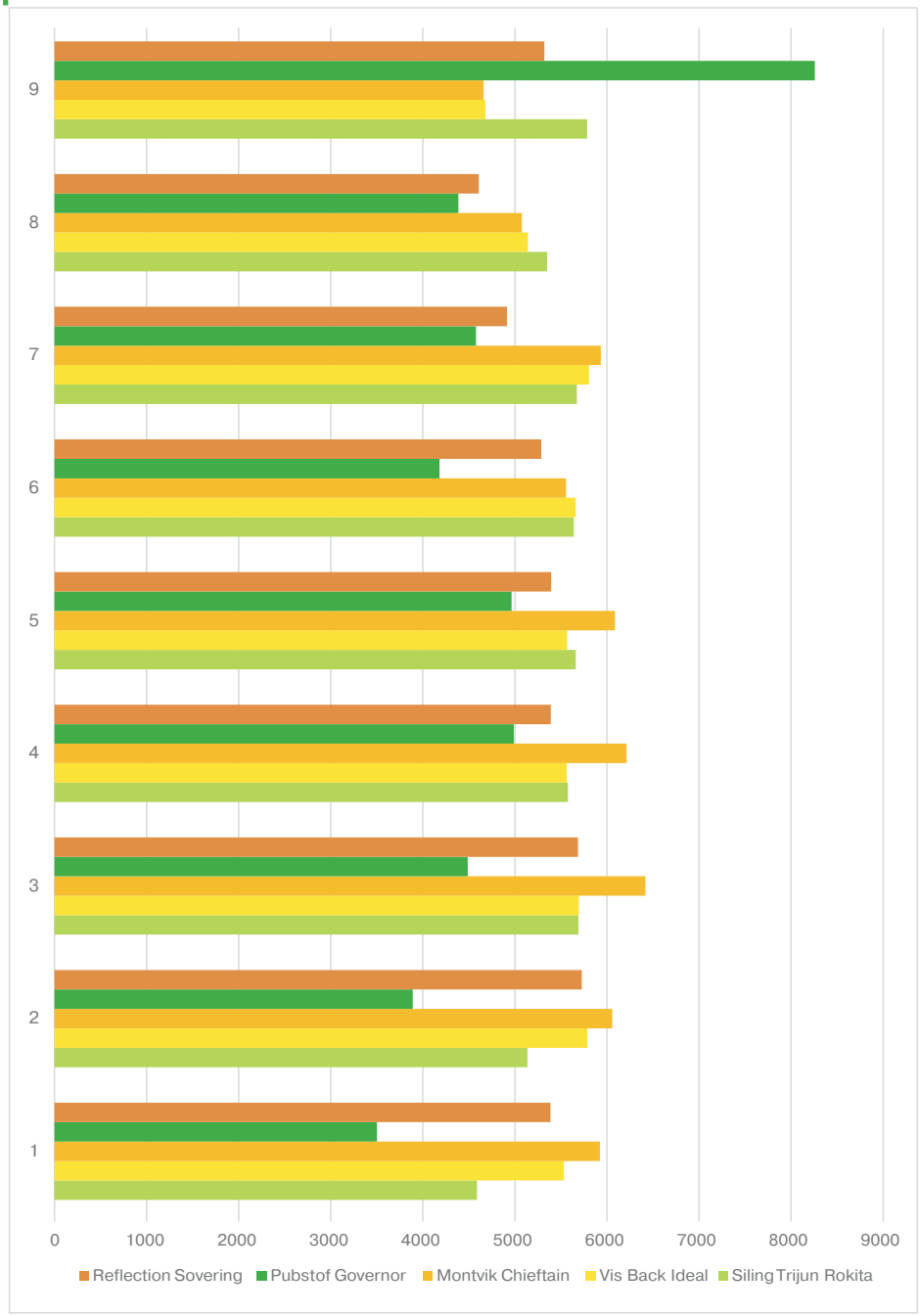
Milk yield per lactation was higher by 284 kg, or 4.9%, than milk yield in 305 days of lactation on average in the herd due to longer lactation, which is correlated with duration of a service period (table 3).

The analysis of data on duration of service period and calving interval found that these

Table 3. **Duration of the service period and calving interval for cows by lactation, days**

	Line									
	Siling Trijun Rokita		Vis Back Ideal		Montvik Chieftain		Pubst of Governor		Reflection Sovering	
	service period	calving interval	service period	calving interval	service period	calving interval	service period	calving interval	service period	calving interval
1	113	400	124	411	130	417	123	410	126	413
2	113	400	124	411	115	402	114	401	116	403
3	116	403	115	402	114	401	96	383	114	401
4	106	393	115	402	120	407	138	425	111	398
5	108	395	116	403	117	404	135	422	120	407
6	105	392	113	400	116	403	99	386	125	412
7	107	394	113	400	163	450	134	421	130	417
8	94	381	113	400	138	425	109	396	140	427
9	124	411	83	370	113	400	190	477	136	423
On average	114	401	126	413	129	416	124	411	126	413

Figure 7. Dynamics of milk yield per lactation of cows depending on lactation, kg



periods exceed the optimal duration in all groups of cows along the lines and in cows of different ages. The shortest service and calving intervals were recorded among the cows of Siling Trijun Rokita line, which allows concluding about the influence of reproduction function on the duration of cows use in the herd. The service period and calving interval were the longest among the Montvik Chieftain cows, which duration influenced the milk yield per lactation, but also led to a decrease in productive longevity down to 2.5 lactations, which is 1.5 lactations less than in the group of Siling Trijun Rokita cows.

The decrease in the reproductive functions of cows is also confirmed by such indicators like the frequency of insemination and the coefficient of reproductive capability, which are presented in figure 8 by the lines on average.

The frequency of insemination in cows of all lines is more than 1, with the exception of cows of the Pabst Governor line, where it exceeds 2. This leads to overuse of semen doses and to increase in the cost of obtaining a calf. The low coefficient of reproductive capacity (less than 0.95) indicates the presence of

Figure 8. Frequency of insemination and coefficient of reproductive capability of cows by the lines

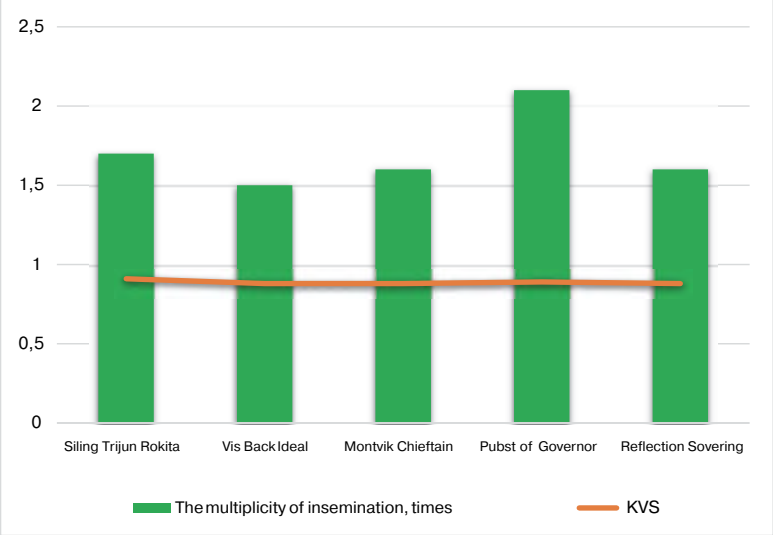
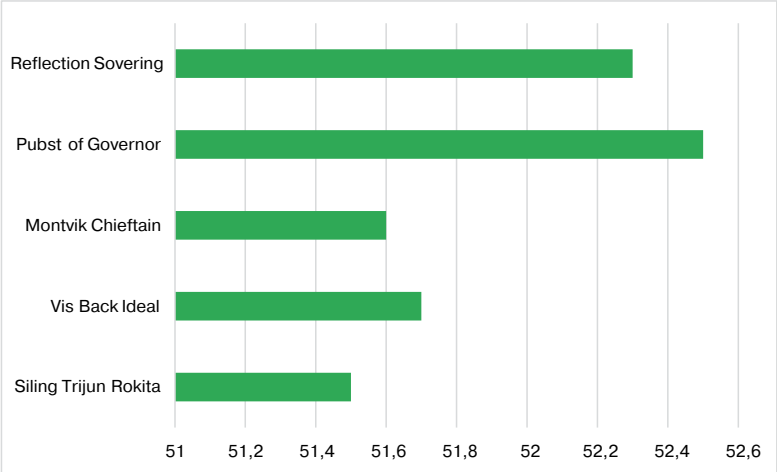


Figure 9. Cows' fertility index by breed line



problems with reproductive functions in the herd, which leads to decrease of productive longevity of cows in the herd as a whole. The best values of this coefficient were recorded in the group of Siling Trayjun Rokita cows, whose productive longevity is 4.0 lactations.

The index of the cows' fertility (Doha index) is an indicator that shows the lifelong fertility of the female cow. These indices are shown in figure 9 for the lines of Holsteinized black-and-white mottled cattle used in pedigree reproducing farms of Sverdlovsk region.

It follows from the figure 9 that the fertility of cows in the herd is quite good, since the fertility index of cows exceeds 48%. Thus, it is possible to say that the potential of the livestock is quite high and can be used for a long time both for milk production and for obtaining of offsprings.

Выводы / Conclusion

Therefore we can conclude that the modern Holsteinized black-and-white mottled cattle bred in Sverdlovsk region possess high breeding qualities, which is confirmed by their productive qualities. The potential of their use is quite high and, despite certain problems with reproduction functions, they can produce for a long time in the environmental and forage conditions of the breeding zone.

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