



Productive Qualities of the Imported Holstein Cows of American Selective Breeding

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ABSTRACT

Dairy productivity and reproductive ability of the third generation offspring of Holstein cattle of American selective breeding, imported to the breeding reproducer of JSC "Belgorod Dairy Farms", were studied by complex researches. The goal was achieved by solving the following tasks: the indicators of milk yield in the animals of the main lines for three complete lactations and the degree of realization of the genetic potential were determined; the indicators of milk yield, fat and protein content in the milk of female ancestors of experimental animals were studied; the reproductive capacity of the analyzed cows was estimated. During the research, the methods used in zootechnics were used. It has been established that the milk productivity of female ancestors of the 1st generation of the evaluated animals for 305 days of first lactation was an average of 7698 kg of milk or 438 kg lower than the milk productivity of daughters - animals of the 2nd generation. The highest milk yields were recorded in the cows of the W.B. Ideal line, 1st generation - 7801 kg and 2nd generation - 8235 kg. In terms of fat content in milk, the animals of the 1st generation of the M. Chieftain line excelled others, the fat content in their milk was 3.85%. The predicted milk yield in terms of cows' parent index in the analyzed groups ranged from 9340 to 9476 kg of milk. The implementation of genetic potential for milk yield averaged 87%. The duration of the first complete lactation in the evaluated animals ranged from 377 to 396 days with an average milk yield of 9537 kg. For 305 days of the first three lactations, milk yield from the cows of the R. Sovereign line was on average 9181 kg of milk or 352 and 199 kg more compared to the lines of W.B. Ideal and M. Chieftain. The animals of the R. Sovereign line were also characterized by the high yield of milk fat (346.6 kg) and protein (302.1 kg). The average duration of the service and interim periods for the evaluated cows was 158 and 436 days. The indicators of the cows of the R. Sovereign line were shorter by 12 and 9 days. From the first insemination, 55.3% of the animals became pregnant. In the cows of M. Chieftain line this index was higher (62%). The coefficient of the reproductive ability of animals was recorded at the level of 0.84.

Keywords: Holstein cattle, milk productivity, line, acclimatization, adaptation, parental index of cow, reproductive ability

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INTRODUCTION

The problem of increasing the volume of milk production is most acute in the structure of

livestock production in the country. The number of cattle in the Russian Federation in 1990 was 57 million heads and according to this indicator the country occupied the fifth place in the world. However, by 2011 the number of animals decreased by 39.1 %, including cows by

47.9 %, and amounted 20.1 and 9.0 million heads, respectively. And this is contrary to the fact that the country has a territory of 7 million km² and takes the leading place in the presence of agricultural land among other countries [1].

Negative dynamics of the number of cattle in the country remains, only its rates have changed, a sharp decrease in the number of livestock has slowed in 2005. According to Rosstat, on 01.01.2017, there were 8.2 million cows in Russia, which is 0.7 % less than in 2016 and 9 % less than in 2011 [2].

At present, Russia occupies the sixth place in the world in terms of milk production. Consumption of milk and dairy products per capita in 2017, according to the estimates of the Ministry of Agriculture of the Russian Federation, amounted to 233.4 kg or 72 % of the rational norm - 325 kg. The share of milk produced domestically is 82% of the total demand, the lack of demand for milk is compensated by imports, amounting to about 7.5 million tonnes [3].

The current situation in the country's dairy cattle breeding requires intensification of the industry on the basis of accelerated qualitative transformation of existing livestock breeds and the creation of new highly productive plant and intra-breed types of animals that meet the requirements of modern milk production technologies. To this end, highly productive animals from European and American countries are imported to the Russian Federation, the breeding stock of which is fill the large specialized dairy complexes [4].

The best of the world's dairy breeds of cattle is Holstein, which is produced by breeders of the United States and Canada, and is used in many countries of the world as an improving breed. From 2000 to 2012, 266089 animals of Holstein breed of black-and-white color were imported into the Russian Federation. 143522 animals were imported the Central Federal District during this period, 33782 of which were taken to the Belgorod Oblast. Holsteinization of domestic dairy cattle allowed a milk yield on a cow for large and medium-sized agricultural enterprises of Russia to exceed the five thousandth boundaries in 2013 [5].

However, along with the positive results of the exploitation of highly productive Holstein cattle, there is also the significant problem: the adaptation of imported animals to new conditions: climatic, fodder, technological [6, 7].

The natural and climatic conditions and the microclimate in the premises have a significant effect on the functioning of the animal organism. It is known that in animals with approximately the same heredity under the influence of different environmental conditions (feeding, care

and maintenance, the peculiarities of use, etc.), the formation and realization of the productive potential is not the same. The phenotypic diversity of traits in animals is determined by the complex interaction of heredity and living conditions [8, 9, 10].

The main purpose of this work was to study the productive indicators and reproductive abilities of Holstein cows imported from the United States under conditions of a dairy complex with a non-tethered animal keeping.

To achieve this objective, the following tasks were accomplished:

- the milk productivity of the animals of the three lines for three complete lactations and the degree of realization of their genetic potential were studied;
- the indicators of milk yield, fat and protein content in the milk of female ancestors of experimental animals were identified;
- the evaluation of the reproductive functions of the analyzed cows was carried out.

MATERIALS AND METHODS OF RESEARCH

These studies were carried out on the livestock of highly productive Holstein cows belonging to the breeding reproducer of JSC "Belgorod Dairy Farms", Ivnyansky District, Belgorod Oblast. Animals for the stocking of the enterprise were imported from the breeding farms of Germany, Holland, Slovakia, the Czech Republic, Hungary and the USA in 2006-2014. When studying the adaptive abilities of animals to new conditions, it is necessary to evaluate their descendants according to the degree of development of economic-useful traits. Therefore, the descendants of the third generation of imported Holstein cattle were chosen as the object of research.

For the random sample research, three animal groups of 15 animals each were formed, representing the main genealogical lines of American selective breeding which are bred on this farm. The cows of the first group belonged to the line Wes Back Ideal 933122, the second - the line Reflection Sovereign 198998, the third - the line Montvic Chieftain 95679. All experimental animals were kept in identical conditions.

Information on the economic and biological characteristics of animals and their production use were taken from the files of the breeding cows of the archive of the zootechnical and pedigree registration program "SELEX - DAIRY CATTLE": individual cards of the 2-MOL form; results of valuation; zootechnical recordings data. The content of fat in the milk of evaluated animals was calculated by the formula: milk yield for 305 days of lactation × mass fraction of fat / 100; milk protein - milk yield for 305 days of

lactation \times mass fraction of protein / 100.

By the milk yield of the mother's ancestors, the parental index of the cow (PIC) was calculated according to the formula: $PIC = 0.25 [2M + MM + MF]$. Where M - the productivity of the mother; MM - the productivity of mother's mother; MF - the productivity of the father's mother.

The degree of realization of the genetic potential (RGP) of animals was determined using the formula: $RGP = \text{actual productivity} / \text{expected productivity by PIC} \times 100$

Reproductive functions of animals were assessed according to: duration of dry, service and interim periods, fertilization, the insemination index, the output of calves per 100 cows, and coefficient of reproductive ability (CRA).

The yield of the calves was determined by the formula: $\text{calves yield} = \text{number of calves born per year} / \text{number of cows in the herd} \times 100$.

The coefficient of reproductive ability (CRA) was determined by the formula: $CRA = 365 / \text{interim period}$.

The digital material of the research was processed using variational statistical methods using a PC in the "Data Analysis" program of Microsoft Office Excel.

RESULTS OF STUDY

The development of any economically useful trait of the animal organism, as is known, is determined by the genotype and conditions of

detention. The quantitative characteristics, including milk production, fat, protein and other components content in the milk, are judged by the phenotype, their manifestation under specific environmental conditions [7, 12].

Productivity indicators for the first complete lactation of experimental cows are presented in Table 1. Analysis of the lactation duration of the first-calves shows that for all animals it was more than 305 days. So in the first group it is longer by 72 days, the second and third by 81 and 91 days, respectively.

From the cows of the 1st group for 377 days of the first lactation, an average of 10035 ± 714 kg of milk was obtained or 6.3 % and 9.9 % more compared to the second and third groups. Concerning the parameters of the mass fraction of fat (MFF) and the mass fraction of protein (MFP) in the milk of the cows under evaluation, an insignificant difference can be noted. The milk productivity of the cows of the studied lines for 305 days of the first lactation differed insignificantly, and averaged: line W.B. Ideal - 8243.5 ± 231 kg; line R. Sovereign - 8154.0 ± 229 kg; line M. Chieftain - 8188.5 ± 228 kg of milk (Table 2). High lactational activity of the W.B. Ideal line animals differed also in the second lactation, when 9534.4 kg of milk and 362.1 kg of milk fat was received from them. However, according to the third lactation, only 8710.5 kg were obtained from them.

Table 1 . Milk productivity of cows for the first complete lactation.

Group	Milking Days	Yield, kg	MFF, %	Milk fat, kg	MFP, %	Milk protein, kg
First	377 \pm 27	10035 \pm 714	3.77 \pm 0.02	357.0 \pm 15	3.27 \pm 0.012	328.14 \pm 12.6
Second	386 \pm 21	9443 \pm 519	3.79 \pm 0.02	357.0 \pm 19	3.30 \pm 0.011	311.6 \pm 10.4
Third	396 \pm 47	9134 \pm 442	3.78 \pm 0.02	327.6 \pm 12	3.28 \pm 0.02	299.6 \pm 13.7

The milk yield of the cows of the R. Sovereign line increased during three lactations and amounted to an average of 10076.5 kg on the third lactation. The greatest yield of milk fat of 378 kg is also noted during this lactation.

Table 2 . Productivity indicators of cows from different lines.

Lactation	Milk yield for 305 days, kg	MFF, %	Milk fat, kg	MFP, %	Milk protein, kg
Group 1					
First	8243.5 \pm 231	3.8 \pm 0.02	313.6 \pm 9.44	3.28 \pm 0.09	270.39 \pm 5.14
Second	9534.4 \pm 537	3.8 \pm 0.02	362.1 \pm 19.22	3.26 \pm 0.01	310.82 \pm 9.17
Third	8710.5 \pm 260	3.78 \pm 0.02	329.9 \pm 10.62	3.27 \pm 0.01	284.83 \pm 6.09
Average	8829.5 \pm 377.4	3.79 \pm 0.01	335.0 \pm 14.2 5	3.27 \pm 0.01	288.72 \pm 11.04
Group 2					
First	8154.0 \pm 229	3.78 \pm 0.02	308.4 \pm 9.27	3.3 \pm 0.01	269.08 \pm 8.06

Second	9312.6 ± 283	3.80±0.02	353.4±10.8 2	3.29±0.01	306.38±12.11
Third	10076.5 ± 331	3.75±0.01	378.0±12.2 3	3.27±0.01	329.5±13.15
Average	9181.0±558	3.78±0.01	346.6±20.4	3.29±0.01	302.1±17.07
Group 3					
First	8188.5±228	3.82±0.04	310.2±9.44	3.30±0.02	270.22±11.14
Second	8910.5±245	3.74±0.036	334±10.5	3.29±0.007	293.14±10.39
Third	9847.0±407	3.75±0.01	369.4±15.4	3.26±0.01	321.01±13.09
Average	8982.0±480	3.77±0.02	337.9±17.2	3.28±0.01	294.60±14.16

The animals representing M. Chieftain line had an increase in milk yield and increased the productivity to 9847 kg of milk and 369.4 kg of milk fat to the third lactation.

On average, for the three lactations, the greatest amount of milk and milk fat was obtained from the animals of the R. Sovereign line, 9181 kg and 346.6 kg, respectively. These animals gave the greatest increase in milk yield in comparison to the first lactation, which amounted to 12.6 %, while in the other two lines it was 7.1 % and 9.7 %. The animals with the least productivity were W.B. Ideal with a milk yield of 8829.5 kg and 335 kg of milk fat. It should be noted that more milk protein was obtained from the cows of the R. Sovereign line, on average 302.05 ± 17.07 kg. Analysis of the milk productivity of the female ancestors of evaluated animals for 305 days of first lactation showed that the milk yield of

individuals of the first generation was inferior to the productivity of daughters - animals of the second generation (Table 3). Among the female ancestors of the first and second generations, the cows of the W.B. Ideal line were characterized by the highest milk yield.

As regards the content of the main components of milk, no significant differences were found between mothers of the first and second generation of both a single line and different lines. This fact indicates a high heritability of traits.

The highest rates for milk yield had the mothers of fathers, more than 13 thousand kg. However, the fat content of milk was lower, which is probably due to a negative correlation between the milk yield and MFF, as well as differing operating conditions.

Table 3 . Dairy productivity of female ancestors of experimental animals.

Indicators	Group		
	1	2	3
Mother (2 generation)			
Milk yield, kg	8235 ± 317	8038 ± 223	8136 ± 326
MFF, %	3.80 ± 0.04	3.82 ± 0.03	3.80 ± 0.03
MFP, %	3.32 ± 0.014	3.3 ± 0.012	3.29 ± 0.018
Mother's mother (1 generation)			
Milk yield, kg	7801 ± 324	7762 ± 269	7530 ± 298
MFF, %	3.80 ± 0.035	3.80 ± 0.03	3.85 ± 0.03
MFP, %	3.35 ± 0.010	3.30 ± 0.016	3.30 ± 0.011
Father's mother			
Milk yield, kg	13415 ± 911	14067 ± 682	13556 ± 699
MFF, %	3.7 ± 0.02	3.65 ± 0.04	3.70 ± 0.03
MFP, %	3.4 ± 0.012	3.5 ± 0.015	3.30 ± 0.020

In order to determine the extent to which the productivity of the experimental animals is conditioned by the genotype, the PIC calculations and the level of its implementation in the phenotype were carried out, in conjunction with the attachment to the specific line (Table 4). As follows from the data presented in Table 4, the parental indices did not differ significantly in cows in the section of the lines, which indicates the realization of

phenotypic indicators at approximately the same level.

Heifers of M. Chieftain line stood out by the highest realization of the genetic potential of productivity by the milk yield of 88% with a PIC value equal to only 9340 kg. Hereditary predispositions of milk productivity in animals of the R. Sovereign line appeared somewhat below (86%), while the PIC in this group was the highest - 9476 kg of milk.

PIC by the mass fraction of fat in milk ranged from 100.3 to 100.8 %, the mass fraction of

protein - from 98 to 100 %.

Table 4 . Realization of the parental index for milk productivity.

Indicators	Group		
	1	2	3
PIC for milk yield, kg	9422	9476	9340
PIC for MFF, %	3.78	3.77	3.79
PIC for MFP, %	3.30	3.35	3.30
Actual milk yield, kg	8244	8154	8189
Actual MFF, %	3.8	3.78	3.82
Actual MFP, %	3.28	3.30	3.30
RGP for milk yield, kg	87	86	88
RGP for MFF, %	100.5	100.3	100.8
RGP for MFP, %	99	98	100

Reproductive ability of animals is one of the indicators that indicate their adaptive capacity. Realization of the genetic potential of cows and productivity indicators depend on the intensity of the herd reproduction [13, 14]. The first calving of the cows of the first, second and third groups was obtained at the age of 23.5; 23.2 and 24.4 months.

The average duration of the dry period in the first three lactations in the animals of group 3 was 57 days, the cows of group 1 showed the smallest index of 51.4 days, the animals of the

group 2 had an intermediate value (Table 5).

The cows of the W.B. Ideal line were fruitfully inseminated 167 days after calving, and R. Sovereign and M. Chieftain after 21 and 7 days, respectively.

Other indicators of the reproductive function of animals of the 1st group differed in the worse direction. So in comparison with other groups, the interim period was longer by 20 and 14 days, the fertilization rate is lower by 2.3 and 11 %, the CRA is lower by 3.8 and 2.6 %. The greatest yield of calves per 100 cows was obtained in group 3.

Table 5 . Reproductive qualities of cows.

Lactation	Dry period, days	Service period, days	Interim period, days	Fertility, %	Insemination index	Costs of sperm production, doses	The output of calves, heads	CRA
Group 1								
First three	51.5	167	447	51	2.12	31.6	93.3	0.82
Group 2								
First three	54.5	146	427	53	1.93	29.0	97.6	0.85
Group 3								
First three	57.0	160	433	62	1.91	29.0	98.9	0.84

DISCUSSION OF RESULTS

World experience of dairy cattle breeding testifies that the animals of Holstein breed of American and Canadian selection possess the highest genetic potential of productivity, a specialized type and better adaptability to exploitation in conditions of industrial milk technologies.

The modern milk type of Holstein cattle was created by purposeful selection according to the minimum number of traits, mainly according to the milk yield level, taking into account the overall yield of milk fat, the type of physique against the background of abundant full-fledged feeding [14, 15, 16].

Large dairy enterprises using modern technological processes can increase the production of milk in the country. In the conditions of non-tethered animal keeping, large dairy herds should be homogeneous in terms of productivity, manufacturability and ethological characteristics.

One of such enterprises is the JSC "Belgorod Dairy Farms", where the average annual number of cows for a past few years is about 5000 heads. This enterprise was also equipped with animals of Holstein breed of American selective breeding with a high potential for dairy productivity, but for its implementation in new natural climatic

conditions of keeping and feeding they had to be acclimatized and adapted.

Milk productivity is one of the important breeding features during the evaluation of cattle. A number of researchers express the opinion that during animals' adaptation it is necessary to take into account the conditions in which the organism grows and develops [17, 18, 19, 20].

In our studies, the descendants of the third generation of the R. Sovereign line showed better milk yield to the third lactation, and their average milk yield was higher than that of the other two analyzed lines by 4.0 and 2.2 %. From the cows of this line more milk fat and milk protein received.

The milk yield of the offspring and the degree of realization of the potential are directly dependent on the milk yield of the ancestors, mothers of fathers and mothers. The productive qualities of the fathers' mothers form the basis of the selection differential on the traits of productivity in its and subsequent generations.

Productivity of animals in qualitative indicators of female ancestors PIC, showing the genetic capabilities of the animal and the degree of possible transfer to the offspring of productive qualities, that is, the pressure of the ancestral genotype on milk productivity of daughters.

The milk productivity of the fathers' mothers in the estimated livestock was more than 13 thousand kg of milk. The results of the conducted studies showed that the productivity of fathers' mothers and mothers plays a dominant role in the formation and realization of the productive potential of offspring. PIC for milk yield exceeded the 9000 mark: at the heifers of the W.B. Ideal line- 9422 kg; R. Sovereign line - 9476 kg; M. Chieftain line - 9340 kg.

A comparison of actual productivity with PIC showed that in all groups of experimental animals a high degree of realization of the genetic potential of cow productivity was established, which on average was 87% for milk yield, 100.5 % for MFF and 99% for MFP.

Animals with high reproductive qualities are the basis for profitability and competitiveness of the dairy cattle industry. Studies of domestic and foreign scientists have shown that in cows with an increase in milk productivity, their reproductive qualities and the period of economic use are reduced [21, 22, 3].

A number of authors in their studies indicate that the growth in milk production largely depends not only on the milk productivity of cows, but also on the organization of the reproduction of the herd. Optimal is the duration of the service period not less than 80 days, and interim period - 365 days. This ratio allows to receive one calf from the cow annually. With the

service period of 60 to 120 days, an increase in productivity is observed in animals, a further increase after 120 days leads to a decrease in milk yield [24, 25, 26].

In our experiment, the duration of the service and interim periods during three lactations for the analyzed animals was on average 158 and 436 days. The best indicators were observed in the cows of the R. Sovereign line (146 and 427 days). Animals of this line were characterized by a higher coefficient of reproductive ability.

CONCLUSION

1. Milk productivity of female ancestors in first generation of the estimated animals for 305 days of first lactation was in the range of 7698 kg of milk or 438 kg lower than in daughters - animals of the second generation. The highest milk yields were recorded in the cows of the W.B. Ideal line: first generation - 7801 kg; second generation - 8235 kg.
2. The duration of the first lactation for the estimated livestock was on the average 386 days, with fluctuations in groups from 377 to 396 days with milk yield of 9537 kg. The greatest productivity was recorded in the cows of W.B. Ideal line - 10035 kg.
3. The prognosis of milk yield by indicators of the parental index of cows in the analyzed groups was 9422, 9476 and 9340 kg of milk. The realization of the genetic potential for milk yield is higher in the third group - 87 %, which is 2 % more than in the second group and 1 % more than in the first group.
4. Productivity of cows for 305 days for three lactations averaged 8997.5 kg of milk with a fat content of 3.78 % and protein of 3.28 %. The animals of the R. Sovereign line had the best indicator of milk productivity - 9181 kg. Exceeding the milk yield in comparison with the W.B. Ideal line was 352 kg, or 4 % and 199 kg, or 2.2 % - with the M. Chieftain line. The cows of the R. Sovereign line (second group) had a greater yield of milk fat and protein.
5. The duration of the service and interim periods on average for three lactations per groups was 158 and 436 days. The animals of the R. Sovereign line were characterized by the best indicators - 146 and 427 days. Average fertility of cows from the first insemination was within 55.3 %. Animals of M. Chieftain line differed in this indicator (62 %). The index of the reproductive capacity varied from 0.82 (group 1) to 0.85 (group 2) and 0.84 (group 3).
6. The results of the conducted studies allow us to conclude that the adaptation process of

imported animals to new natural, climatic and technological conditions has been quite successful.

Proposal for Production

The comparative study results of the productive characteristics of the offspring of imported cows of the American selective breeding of three lines in the Belgorod Region showed that the animals of Reflection Sovereign line have an advantage in a number of productive qualities. We consider it expedient to use animals of this line in the further plans of selection and breeding work of JSC "Belgorod Dairy Farms".

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