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Influence of Paratypic Factors on the Productivity of Holstein Cows

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***Abstract* — The article presents the dataset on the influence of paratypic factors on the productivity of Holstein cows. The best indicators of productivity were revealed in the cows with a live weight of 400-449 kg at the first successful conception. The milk yield amounted to 8863.2 with a fat mass fraction of 3.1% and a protein mass fraction of 4.5%. The animals calved for the first time at the age of 24-25 months showed the productivity of 8883.7 kg, which is 101.7 kg more than that showed by 22-23-mo-of-age cows and 628.5 kg less than the herd average. There is a positive correlation of 0.42 between the age at first calving and the mass fraction of fat. The analyzed 10% of livestock have a service period of less than 60 days, 24% - from 61 to 90 days, 26% - from 91 to 120 days.**

Keywords — Holstein cattle,service period, the age of first calving, live weight, correlation.

I. INTRODUCTION

Dairy cattle's breeding is currently one of the most fastest-growing branches of domestic animal husbandry. In the Tyumen region, modern facilities are massively being put into operation where milk production is based on the use of highly productive animals with a world-class genetic potential [1].

The Holstein gene pool being actively distributed, along with the rise in the productive potential, leads to the reduction in the timeline of dairy cattle economic use. In this regard, livestock breeders in many countries are gravely concerned about the existing situation, since the issues of productive longevity are of both selective and economic importance [2-8].

The Holstein breed is highly valued as the highest-production dairy animals and as the most technologically advanced and economical with regard to cattle breeding intensification and market relations.

The Holstein breed of dairy cattle in the USA and Canada is the world's most highly productive. It has broken almost all world records for milk and butter fat production. In a 305-day lactation period the American cow Muranda Oscar Lucinda is known to have produced 30870 kg of milk with fat content of 3.3% [9]. The breed is famous for large body weight (650-725 kg) and sufficient height (height at withers is 141-147 cm). Holstein studs have these indicators equal to 1100-1200 kg and 165-167 cm, respectively. Animals of this breed feature early maturity. They are selected to be adaptable for use in modern industrial production and have high adaptation qualities [3].

In animal husbandry, 60% of success is amounted to cattle diets, 20% – to genotype and age, and 20% – to microclimate and animal welfare [10].

The impact of hereditary and non-hereditary factors on different milk production indices differs. Milk yield is more affected by environmental conditions, whereas fat and protein content – by heredity.

Animal welfare most significantly affects cow's milk producing qualities including both milk yield, fat content and the composition of milk as a whole.

Many authors believe that, in addition to genetic factors, feeding system influences productivity and cattle reproduction. With inadequate feeding, milk yield is the first index that drops, while fat content may even rise slightly but afterwards decrease, though [11-13].

To unlock the genetic productivity potential, it is necessary to fully satisfy the body's needs at all stages of growth and development. The composition and nutritional value of the diet should meet the consumption standards. Both nutrient shortage and excess can have a negative impact on the growth, development and health of cows. The latter can cause the risk of obesity and a cut in the reproductive ability of cows [14, 15].

The cow's growth rate and heifer's conception time have their own characteristics that primarily depend on the early maturity of the breed and the diet during all periods of growth. In the new framework of industry intensification, the requirements for the quality of milk production are increasing. All this makes it necessary, as long as scientific and production materials are being accumulated, to use them to raise replacement cattle.

Determining the most optimum live weight of cows, at which high milk production is achieved, is of practical interest at different stages of dairy cattle breeding [16].

The main way to increase livestock production is the rational use of the genetic resources of the livestock industry. The service period is a normal period of a cow's physiological cycle, during which it must be prepared for effective conception. The duration of service period as a production indicator gives a general idea of the reproductive ability of both the herd as a whole, and each cow in particular [17].

There is no consensus on the duration of service period and conception of cows after calving. A number of scientists agree that conception should be carried out in the first month after calving, while others consider the optimal period of conception to be from 60 to 90 days after calving.

The influence of the duration of service period on the longevity and lifetime productivity of cows was studied [18, 19]. Consequently, it was found that the cows with the duration of service period of 120–150 days have the highest rates of lifetime milk yield and the duration of economic use. With advancing age, the relationship between the length of intercalving periods and lifetime milk yield produced significantly increased.

The dry period is the most crucial moment in dairy cattle breeding. It is when the ground for the clinical status of the mother and its offspring, the effectiveness of lactation and the subsequent reproductive functions of females are laid [20].

Subject to the age and lifetime production, the dry period lasts 45-60 days. With a significant reduction in the dry period, the yield in the next lactation goes down. The calves are smaller and weaker, as the cows do not have time to compensate for the growth of fetus and replenish nutrient reserve. The cows that were not given a rest period after calving produce less and poor quality colostrum required for a newborn calf [21].

The paper aims to study the influence of paratypic factors on the productivity of Holstein cows.

II. Material and Methods

The studies were carried out at the breeding plant of PAO Ptitsefabrika Borovskaya specializing in breeding purebred Holstein cattle.

The object of study was the Holstein cows, the studs of the lines: Vis Beck Ideal 1013415 (V.B. Ideal), Montvic Chieftain 95679 (M. Chieftain), Reflection Sovering 198998 (R. Sovering).

The following production and pedigree registration data were subject to analysis: control milking, animal weighing, artificial insemination, cow breeding cards, and stud catalogs.

The productive qualities of Holstein cows were assessed depending on the length of service period, the age at first calving, live weight registered at first successful conception.

During the scientific and economic experience, all animals were managed on equal terms. Feeding was carried out according to the diet adopted on the farm, taking into account the period of lactation, lactation performance, body weight and physiological state.

III. Results

Apparently, cows produce different milk yield and its composition, especially mass fraction of fat and protein, are changeable due to a number of factors like genetic (breed, origin) and paratypic (age at first calving, body weight, service period).

Service period is a normal period of each cow's physiological cycle, during which she must be prepared for effective mating.

There is no general consensus among scientists on the duration of service period and insemination of cows after calving. Some argue that the insemination of cows should be carried out in the first month after calving, while others consider the period from 60 to 90 days after calving to be the optimal period for insemination [22].

Exploring the relationship between the service period and milk production, almost all of them come to the conclusion that with an increase in its duration, the milk yield per standard lactation increases. That is explained by the physiological characteristics associated with gestation period of a cow. This suggests that the later a cow becomes pregnant, the more milk per lactation she can give, although this is not objective in terms of the efficient use of the animal [23]. The level of cow's milk production depends on many factors including the duration of the interval from calving to effective conception or service period.

The influence of the duration of service period on the productivity of cows is presented in Table 1.

TABLE 1 – INFLUENCE OF THE DURATION OF SERVICE PERIOD ON THE PRODUCTIVITY OF HOLSTEIN COWS, $\overline{X} \pm S\overline{x}$

Index	Service period, days				
	<60	*61-90*	*91-120*	*121-150*	*151>*
Yield, kg	7334.5±103.1	7720.6±89,9	8472.7±90.2	8820,4±100.9	10441.3±155.8
Mass fraction of fat , %	4.3±0.07	4.4±0.07	4.4±0.06	4.4±0.07	4.4±0.05
Mass fraction of protein, %	3.1±0.02	3.1±0.02	3.1±0.01	3.1±0.01	3.2±0.01
Butter fat, kg	312.0±5.5	346.2±6.3	371.6±6.1	392.1±7.4	458,9±9.0
Milk protein, kg	230.6±3.4	242.0±2.8	265.3±3.1	275.2±3.3	332.3±5.3

The data in the table proves that of the analyzed livestock 10% of cows have a service period of less than 60 days, 24% – from 61 to 90 days, 26% – from 91 to 120 days, 12.7% – from 121 to 150 days and 27.3% – more than 150 days.

When the service period lasted less than 60 days, the milk yield was 7,334.5 kg, and when it took 91-120 days, the milk yield per lactation was 1138.2 kg more. This can be explained by the fact that cows need more time to recover, as highly productive livestock cannot recover in 60 days. The longer the service period, the greater the milk yield. Thus, with a service period of 150 days or over, a cow can produce 10,441.3 kg against 8,472.7 kg with a service period of 91-120 days. The mass fraction of fat and protein remains consistently constant and amounts to 4.3-4.4% and 3.1-3.2%, respectively. At the

same time, extending the service period, the farm does not receive an output of calves per 100 cows.

In animal husbandry, breeders constantly solve a difficult task of how to create the dairy herd with an optimal combination of milk yield and fat content.

The relationship between the duration of service period and production indices are given in Table 2.

TABLE 2 – CORRELATION BETWEEN THE DURATION OF SERVICE PERIOD AND MILK PRODUCTION INDICES

Index	r±Sr
Milk yield in a 305-day lactation period , kg	0.81±16.091
Mass fraction of fat, %	0.03±0.812
Mass fraction of protein, %	0.16±3.158
Butter fat, kg	0.68±13.343
Milk protein, kg	0.80±15.904

Indeed, a strong correlation was revealed between the milk yield obtained in a 305-day lactation period and the service period. The correlation between the duration of service period and the mass fraction of protein is 0.16. A weak positive correlation between the service period and the mass fraction of fat is 0.03.

Converted to basic indicators the milk production rate was 9,576.7 kg in a service period of less than 60 days. It was 4,826.1 kg less than in a service period of more than 151 days and 1,759.7 kg less in a service period of 91-120. When calculating an incremental cost, it became clear that cows with a service period of 91-120 days produced a revenue of 25.3 thousand rubles, while cows with a service period of 121-150 days yielded 30.6 thousand rubles.

Paratypic factors also comprise the age at first calving. The influence of the age of the first calving on the productivity of Holstein cows is presented in Table 3.

Of the analyzed livestock, 77% of the heifers calved at the age of 24-25 months, 11% – at 22-23 months and 12% – at the age of 26-28 months. Cows that calved for the first time at 24-25 months of age produced 8883.7 kg of milk, which is 101.7 kg more than that at the age of 22-23 months and 628.5 kg less than the herd average (P>0.999). The mass fraction of fat is reliable when the age at first calving is 24-25 months and makes up 4.4 (P>0.95), which is 0.3% less than that at the age of 25-26 months (P0.95).

There is a positive strong correlation of 0.79 between the age at first calving and the yield. A negative weak correlation is observed between the calving age and the mass fraction of protein (%) and milk protein (kg) and amounts to -0.05 and -0.04, respectively. A positive reliable between the age at first calving and the mass fraction of fat was 0.42 (P>0.999). Besides, the correlation between the age at first calving and milk fat is highly reliable and amounts to +0.25 (P>0.999).

TABLE 3 –INFLUENCE OF THE AGE OF THE FIRST CALVING ON THE PRODUCTIVITY OF HOLSTEIN COWS, $\overline{X} \pm S\overline{x}$

Index	Age of first calving, mo.		
	22-23	*24-25*	*26-28*
Milk yield, kg	8,153.5±237.8	8,883.7±101.5*	8,799.0±96.6*
Mass fraction of fat, %	4.2±0.06	4.4±0.03*	4.7±0.04*
Mass fraction of protein, %	3.2±0.01	3.1±0.01	3.2±0.01
Butter fat, kg	340.4±10.9	389.3±5.7*	426.1±6.0*
Milk protein, kg	260.7±7.5	280.4±3.7	288.2±3.5

When converted to basic indicators, the economic efficiency of milk production proved that when the age at first calving is 22-23 months, the productivity of cows is 10,734.2 kg of milk, which is 1,140.7 kg less than that index at the age of 24-25 months and 2,228.6 kg of milk less than at the age of 26-26 months. An incremental cost derived from first-calf cows was 17.6 thousand rubles.

Live weight at first successful conception also refers to paratypic factors. The analysis of the effect of body weight on productivity is presented in Table 4.

TABLE 4 – EFFECT OF BODY WEIGHT ON HOLSTEIN PRODUCTIVITY, $\overline{X} \pm S\overline{x}$

Index	Live weight at first successful conception, kg	
	350-399	*400-449*
Milk yield, kg	8640.7±164.79	8,863.2±100.48
Mass fraction of fat, %	4.1±0.03	4.5±0.04*
Mass fraction of protein, %	3.2±0.01	3.1±0.01
Butter fat, kg	354.8±6.57	407.6±6.16*
Milk protein, kg	276.2±5.35	282.3±3.63
Dairy ratio, kg	2226.2±21.59	1973.8±32.52

The analysis of the dataset presented in the table leads to the conclusion that when live weight observed at successful mating is over 400 kg, the productivity of first-calf cows is 222.5 kg more than that of the cows with a live weight of up to 400 kg.

The mass fraction of fat in the second group was 4.5%, which is 0.1% more than the herd average (P>0.95). Comparing the above data with the herd average enables to conclude that the first group with a live weight ranging from 350 to 399 kg at the first effective insemination has lower values. Thus, the difference between the yields was 141.3 kg, the mass fraction of fat – 0.3% and the mass fraction of protein was the same.

The dairy ratio of cows with a live weight of 350-399 kg at the first effective insemination was 2,226.2 kg, which is 252.4

kg more than that of cows with a live weight at the first effective insemination of 400-449 kg.

When converted to basic indicators, the amount of milk produced by cows with a live weight of 400-449 kg at the first effective conception is 12,113.0 kg, which is 1,013.8 kg more than that of cows with a live weight of 350-399 kg. With the sales of milk amounting to 22.75 rubles, the incremental cost from cows with a live weight of 400-449 kg at first effective conception made up 15.9 thousand rubles.

Consequently, the more optimum live weight of heifers at first effective conception is 400-449 kg, which is higher than the breed standard. The milk productivity of cows was 8,863.2 with a mass fraction of fat and a mass fraction of protein 4.5 and 3.1%, respectively.

Thus, the studies conducted into the impact of the longevity of service period on the milk productivity of first-calf Holstein cows, make it possible to conclude that the service period affects milk yield, butter fat and milk protein. The use of first-calf cows with a service period of no more than 91-120 days can be considered as the most effective, provided that the milk yield was averaged in the herd under study.

The content of fat and protein is high, the mass fraction of fat is 4.4%, while the mass fraction of protein is 3.1%. A positive strong correlation of 0.813 is observed between the length of service period and the milk yield.

When the age at first calving was 24-25 months, the productivity of cows was 8883.7 kg, 101.7 kg more than the herd average. When the age at first calving was 22-23 months, milk yield amounted to 8153.5 kg, with a mass fraction of fat and protein of 4.2 and 3.2%, respectively. The mass fraction of fat is greater in the calving interval of 26-28 months and amounts to 4.7%. Most cows calved at the age of 24-25 months – 77%, at 22-23 months – 11%, at 26-28 – 12%. The positive strong correlation was 0.79 between the age at first calving and milk yield.

The negative weak correlation is observed between the calving age and the mass fraction of protein (%) and the milk protein (kg) and amounts to -0.05 and -0.04, respectively.

References

[1] L. Yarmots, M. Volynkina, “Dairy productivity of imported cows of different lines in the Tyumen region”, Glavnyi zootekhnik, 2014, No7, pp. 17-23.

[2] L.Yu. Ovchinnikova, “The influence of individual genetic factors on life-time productivity of cows”, Actual problems of veterinary medicine and animal and plant production: proceedings of the Int. scientific-practical conf., Troitsk: SUSAU, 2006. -P.297-301.

[3] P.N.Prokhorenko, “Holstein breed and its influence on the genetic progress of the black-and-white cattle productivity in European countries and the Russian Federation”,/ Dairy and Beef Cattle Breeding,2013, No 2, pp.2- 6.

[4] T.V. Shishkina, N.V. Nikishova, A.V. Naumov, “The influence of Holstein pedigree on milk production and life-time productivity of black-motley cows”, Glavnyi zootekhnik, 2017, No 12, pp. 22-26.

[5] N.I. Abramova, O.N. Burgomistrova, O.L. Khromova, “The relationship of life-time productivity of dairy cows with Holstein pedigree, Zootechniya, 2018, No. 1, pp.12-16.

[6] A.Oler, A.Sawa, P.Urbańska, “Analysis of longevity and reasons forculling high-yielding cows”, Zootechnica, 2012, vol. 3, No. 11, pp.57-64.

[7] H. Martens, C. Bange, “Longevity of high-producing dairy cows: a case study”,Lohmann information, 2013, vol. 48, pp.53-57.

[8] M.A. Chasovshchikova, et. al, “Relationship between the genetic variants of kappa-casein and prolactin and the productive-biological characteristics of cows of the black-motley breed”, Journal of Pharmaceutical Sciences and Research, vol. 9, No. 7, 2017, pp. 1038-1044, http://www.jpsr.pharmainfo.in/Documents/Volumes/vol9Issue07/jpsr09071704.pdf

[9] A. Zheltikov, N. Kostomakhin, O. Venediktova, “Milk productivity of first-calf cows of Holstein and Simmental breeds raised in the Novosibirsk region”, Glavnyi zootekhnik, 2017, No 2, pp. 23-30

[10] Kudrin, M. The role of microclimate in the productivity of cows / M. Kudrin // Animal Breeding of Russia. - 2011. - No8.- P.33-34.

[11] G.A. Yarmots, A.B. Satkeeva, L.P. Yarmots, “The use of natural feed additives to increase the productivity of animals”, Feeding of agricultural animals and feed production, 2016, No 4, pp. 16-25.

[12] G.A. Yarmots, L.P. Yarmots, “Mineral nutritional value of feed in the conditions of the Northern Urals”, Feeding of agricultural animals and feed production, 2015, No 4, pp. 59-65.

[13] G.A. Yarmots, L.P. Yarmots, “The use of organic microelements in the diet of highly productive cows”, Feeding of agricultural animals and feed production, 2013, No 7, pp. 64-68.

[14] V. Volgin, “Cultivation of breeding heifers of Holstein black-motley breed”. Glavnyi zootekhnik, 2011, No 3, pp .8-14.

[15] L.P. Yarmots, G.A. Yarmots, “Improving the efficiency of milk production by using new feed additives in cattle diet”, Feeding of agricultural animals and feed production, 2015, No 9, pp. 34-39.

[16] A.A. Velmatov, A.V. Erzamaev, T.N. Tishkina et al, “Productive qualities of a hybrid of Simmental and Holstein breeds”, Glavnyi zootekhnik, 2018, No 1, pp. 43-50.

[17] E.N. Rachkova, “The influence of service period on the dairy productivity of Holstein cows in connection with genetic aspects”, Scientific notes of Kazan State Academy of Veterinary Medicine named after Bauman, 2017, vol. 230, No. 2, pp.114-117.

[18] T.M.Tarchokova, O.A.Batyrova, V.M.Ashkhotov, “The influence of environmental factors on the life time yielding capacity and the duration of economic use of cows”, Agrarian Bulletin of the Urals, 2011, No 7, pp. 38-39

[19] S. G. Kulikova, V. G. Marenkov, N. N. Yolkin, “Reproductive qualities of cows of different ages and their relationship with life-time productive signs”, Bulletin of NSAU, 2012, No 1, pp.64-68.

[20] E.M. Frolova, D. Evstafieva, A.M. Gavrikov, “The influence of certain factors on the producing ability of highly efficient cows and heifers”, Zootechniya, 2014, No 10, pp. 28-29.

[21] S.L. Gridina, “Reproductive ability of black-motley breeds of the Ural type”, Zootechniya, 2005, No 3, pp.30-31.

[22] L. Shabunin, O. Nazarchenko, “Influence of various factors on the milk productivity of black-motley cows”, Glavnyi zootekhnik, 2016, No 3, pp. 53-61.

[23] M.A. Chasovshchikova, “The influence of service period of dairy cattle on the productivity of black-motley cows”, Bulletin of the Krasnoyarsk SAU, 2012, No 10, pp. 136-138.