Ways of improvement of herds, the development and verification of the mate selection method

G.H. Giloyan1*, and N.A. Kasumyan2

1Armenian National Agrarian University, Yerevan, Armenia
2Ministry of Economy of the Republic of Armenia, Yerevan, Armenia

Abstract. The research was performed in Shahumyan “Agroservice” OSC cattle pedigree farm. The verification of the performed selection and mate selection by mathematical analytical method confirms that, by the targeted breeding of newborns obtained by the use of the bulls of Austrian Swiss breed, in the first birth of F2 generation it’s possible to increase the average productivity of the given herd from 2500 kg to 5734 kg. Thus, we suggest applying diagram 1 for the purposes of maintaining and improving the Brown Caucasian breed. Within the framework of the program of cattle breeding development in the Republic of Armenia for the period 2019-2024, established by RA government decree N 327-L of March 29, 2019, it’s been intended to replenish the herds with pedigree cattle of valuable production-economic features, instead of animals of unknown origin, unfit for reproduction and of low productivity, and to develop the pedigree work. It’s known that the cattle breeding in the Republic is performed with the generation obtained by free mating with underdeveloped bulls of low productivity. For this reason, underdeveloped calves of low living mass are born, and the considerable part of them are bred in insufficient conditions of feeding and stall housing, thus impeding the renewal and replacement of herds with heifers that meet the requirement of the breed first class living mass.

1 Introduction

In the agricultures of the Republic of Armenia, animals of different blood breeds are being bred. During the last 30 years, the works of the cattle breeding initial and pedigree registration have collapsed, except for major leading economies [1].

Currently, cattle breeding is considered the main production branchf improvement of rural social-economic conditions, and the related activities need radical transformation and improvement. In this regard, the selection process of animals needs to be performed based on modern genetic patterns. Our observations have shown that the animals bred in the cattle breeding agricultures of the Republic are mainly of unknown origin, have low productivity,

* Corresponding author: garnikgiloyan1937@mail.ru
and, because of the free stall housing system malnutrition, don’t display satisfactory features that are typical of the Brown Caucasian breed [3, 5, 6].

2 Material and methods

The research was performed in Shahumyan “Agroservice” OSC cattle pedigree farm [2]. Within the framework of the program of cattle breeding development in the Republic of Armenia for the period 2007-2015, established by RA government decree N 336-A of March 22, 2007, the heifers of Swiss and Holstein breeds imported from Austria originally have high indicators of milk productivity. The data analysis has shown that the productivity of mothers of fathers of the expected generation of the Austrian Swiss breed exceeds that of the mothers of the fathers of mothers by 1010 kg (8.87 %) for the milk quantity, and by 43.6 kg (4.9 %) for the milk fat + lactalbumin quantity. Consequently, in case of the targeted breeding of male and female offspring born from the heifers, it becomes possible to replenish the herds with animals of high productivity and have male generation obtained by the own reproduction and breed them as breeders obtained by custom mating, using them for the mating of both half-blood and Brown Caucasian cows [4, 7].

3 The results and analysis

According to diagram 1 of interbreeding, based on the data of milk quantity and fat content in the milk, we can calculate the pattern of intermediate inheritance of the qualities of mating Brown Caucasian cows and the mothers of Austrian Swiss bulls in F1 and F2 generations. The average milking of Brown Caucasian cows selected for interbreeding is 2500 kg, the average content of fat in the milk is 3.9 %, lactalbumin 3.2 %, the quantity of milk fat is 97.5 kg, the quantity of lactalbumin is 80 kg, the quantity of milk fat + lactalbumin is 177.5 kg. The average milking of the mother of Austrian Swiss bull number A1 used for mating is 12770 kg, the content of fat in the milk is 4.0 %, the lactalbumin is 3.3 %, the quantity of milk fat is 510.8 kg, the quantity of lactalbumin is 421.4 kg, the quantity of milk fat + lactalbumin is 932.2 kg.

The genetic capacity of milk productivity of the generation born from interbreeding is the following: the milking is 7635 kg; the actual expected milk quantity is 5334 kg which forms 69.9 % of the capacity of milk quantity. The capacity of milk fat + lactalbumin quantity is 554.9 kg, the actual expected quantity is 385.8 kg.

Starting from 2008, the authors have continued to propose the diagram of improvement of Brown Caucasian breed with the use of Austrian Swiss breeders (Figure1):
Fig. 1. Interbreeding of Brown Caucasian cows with Austrian Swiss breeders.

To obtain $F_2$ generation, it’s necessary to breed in a targeted way the half-blood female offspring, obtained by interbreeding Brown Caucasian cows and Austrian Swiss number A1 bull, and inseminate with the semen of Austrian Swiss number B2 bull whose mother’s milking is 12965 kg, the fat content in the milk is 3.9 %, the content of albumen is 3.3 %, the quantity of milk fat is 505.6 kg, the quantity of lactalbumin is 427.8 kg. The genetic capacity of $F_2$ generation is the following: the milking is $(5334 + 12965): 2 = 9150$ kg, the actual expected milking forms 60% of genetic capacity or 5490 kg. The genetic capacity of milk fat + lactalbumin quantity is $(554.9 + 933.4): 2 = 744.2$ kg, the actual expected quantity is $(744.2 \times 60): 100 = 446.5$ kg.

It’s possible to ensure the given data of productivity if the crossbred female calves are bred in a targeted way according to the diagram of milking period feeding of the calves, in the 6th month – 150 kg, in the 18th month- 430 kg of living mass and be inseminated, during the pregnancy ensure 400 g average daily weight growth, give birth in the 27th month [8, 10]. During the lactation period, each one must be given 11 feed unit daily, and the quantity of the condensed food in the ration must reach 30 %.

Using the indicators of some genetic parameters ($\text{Lim}, M \pm m, \sigma, \text{Cv}, r, R1/2, R2/1, h2$) and selection intensity ($P, u, i$) calculated for experimental animals we have predetermined the selection efficiency of milk productivity of crossbred cows (1/4 Brown Caucasian x 3/4 Austrian Swiss), obtained by the breeding of $F_2$ generation in itself, selected in the pedigree kernel during one generational change, having the selection differential (the difference of the average productivity of the selected animals and the herd) which is expressed by sigma.
(σ), defined by the formula $SD = i \times \sigma$, the specific weight (P) of the selected animals (pedigree kernel), the value of the selection intensity (i) which shows the difference of sigma of the minimum limit of productivity (V min) of the selected animals from the arithmetic average [9, 11].

The pedigree kernel includes 50% of cows, while 5% of male generation is kept as breeding bulls, hence Pmother = 0.5; Pfather = 0.05.

Since the selection will be performed by two features simultaneously, according to each feature:

- $P_{mother} = 0.7$, $i = 0.4970$, $u = -0.52$
- $P_{father} = 0.2$, $i = 1.4015$, $u = 0.84$

The mean square deviation of milk quantity is $\sigma = 320$, the mean square deviation of the fat in the milk is $\sigma = 0.06$.

The minimum milking of the selected cows:

\[
V_{min} = M_{average} + u \times \sigma \\
V_{min} = [5490 + (-0.52) \times 320] = 5656 kg
\]

This means that the cows with up to 5656 kg milk yield can be included in the pedigree kernel.

To determine the efficiency of selection, we have calculated the selection differentials of cows and bulls:

- $SD_{mother} = i \times \sigma = 0.4970 \times 320 = 159 kg$,
- $SD_{father} = i \times \sigma = 1.4015 \times 320 = 448.5 kg$.

The heritability coefficient of the milk yield of cows is $h^2 = 0.25$. The selection efficiency during one generational change, according to the milk yield of cows and the fat variation in the milk, is defined by the following formula:

\[
SE = \frac{SD_{mother} \times h^2 + SD_{father}}{2}
\]

where $SE$ - the result of selection

- $SD_{mother}$ - selection differential of mothers,
- $SD_{father}$ - selection differential of fathers,
- $h^2$ - heritability coefficient

For the quantity of milk:

\[
SE = \frac{159 \times 0.25 + 448.5}{2} = 244.1 kg
\]

Thus, the genetic movement of the milk yield of the generation created by the cows of the pedigree kernel is 244.1 kg.

If the selection is performed by one feature, then the modification of the other one is determined by the coefficient of regression (R). In this case, the modification of the milk fat content is determined by the following formula:

\[
R_{1/2} = r \times \frac{\sigma_1}{\sigma_2} = (-0.2) \times \frac{320}{0.06} = -1067
\]

\[
R_{2/1} = r \times \frac{\sigma_2}{\sigma_1} = (-0.2) \times \frac{0.06}{320} = -0.00004
\]
This means that in case of increase of milk fat content by 0.1% we’ll expect decrease of milk yield by 1067 kg.

4 Conclusion

Thus, the verification of the performed selection and mate selection by mathematical analytical method confirms that, by the targeted breeding of newborns obtained by the use of the bulls of Austrian Swiss breed, in the first birth of F2 generation it’s possible to increase the average productivity of the given herd from 2500 kg to 5734 kg (5490 + 244). We suggest applying diagram 1 for the purposes of maintaining and improving the Brown Caucasian breed.

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