EFFECTS OF HERD'S LEVEL OF PRODUCTION ON HERITABILITY OF YIELD TRAITS IN CROSBREED BLACK AND WHITE FIRST-CALVING COWS

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SUMMARY

Heritability coefficients of milk yield traits in standard lactation depend upon genetic variability that is directly affected by mean values and variability of traits investigated. Management, i.e., the herd's production level, when the other influences are mainly similar, results in the changes of additive genetic variance expressiveness, thereby in heritability too.

The investigations of the effects of production level on heritability of yield traits in standard lactation were carried out on the sample of 2947 first-calving cows, daughters of 21 bull-sires, produced on seven dairy farms of the Agricultural Corporation "Beograd". All the first-calving cows were divided into two groups according to the average production of the farms that the cows were raised on: Group A - farms with above average production, and group B - farms with the bellow average production. The same sires were included in both groups. Heritability of milk, milk fat and 4% FCM yields in standard lactation was investigated. In Group A heritabilities were found to be by around 50% higher than in Group B.

Key words: management, level of production, cows, milk yield, heritability, yield traits.

INTRODUCTION

The evaluation of some heritability traits, first of all of those that are desired to be improved genetically, is of primary importance. In addition to providing the measures of genetic variability, the evaluation tells us why it is justified to improve the traits genteically as well as about the methods and procedures that have to be applied in that case. Heritability coefficients of milk yield traits in standard lactation are not constants for all population. They depend upon genetic variability that is directly dependent on mean values and variability of traits under study. Mean values and variabililty of milk yield parameters in each herd - population are conditioned by genotype, population size, level of technology applied, conditions of production, and previous and current selection activities. Literature provides different values for heritability of milk yield traits, The heritability of milk yield is mainly lower than heritabilities of milk fat and 4% FCM yields. This is the consequence of the fact that their phenotypes are also influenced by milk fat content, and individual heterosis effect is more important for its heritability than additive genetic effect. In most investigations the heritability of milk yield was in the 20 to 25% range and above 25% in a lesser number of investigations. According to Tempelman and Burnside (1990) as well as to the results of a larger number of researchers, the heritability of milk yield traits is higher under more favourable conditions of animal raising and in herds with higher average production of milk and milk fat. This is explained by high additive genetic variance and low variance of dominance, which is characteristic of highly productive herd. In herd with higher milk production, Lazarevic *et al.* established heritability of milk yield by almost four times higher (15%). The differences were more pronounced in these researchers' previous investigations (1994) where heritability of milk yield in highly productive head (17.1%) was by seven times higher than in low productive head, and heritability of milk fat yield was by 3.8 times higher (17.7%). In Boldman's and Freeman's (1990) investigations, in highly productive head, the heritability of milk yield was by 1/3 times higher than in low productive head, and amounted to 24%. Hill *et al.* (1983) established the heritability of milk yield (30.2%) in highly productive herd by 1/4 times higher than in low productive herd, i.e., by 1/5 times higher milk fat (28.5%). In populations that are crossed or bred, the potential heterosis effect must be take into account as well as the rest of non-additive genetic effects that are the constituent part of sires' variance. Also, it should be kept in mind that cow selection is mainly performed using bulls highly selected in artificial insemination, which also influences the decrease of both total and genetic variability (Stojic 1993).

MATERIAL AND METHOD

The sample consisted of accomplished lactations of 2497 first-calving cows, daughters of 21 bull-sires, from seven dairy farms of the Agricultural Corporation "Beograd", Padinska Skela-Belgrade, in the period 1990-1992. The first-calving cows are of the Black and White breed, and currently they are being crossed with the Holstein-Friesian breed using Black and White bulls with different rates of HF gene, and semen imported from the USA and Canada. The technology of head raising as well as buildings and equipment are almost equal on all farms. Head are kept tied up in closed and semi-open barns. Milking is done with Alpha laval milking machine system in the morning and in the afternoon. Each worker's daily norm is 60 cows and he does milking from three milking units. The technology of animal nutrition, health management and care is almost alike on all farms. There are differences between the farms in the provision for animal feeds but these differences are not that pronounced. However, there are significant differences in the performance of technology and some working processes that are primarily associated with the staff on the farms. Based on average farm production in standard lactation, all first-calving cows were divided into two groups: Group A - farms with above average production, and Group B - farms with below average production. The same sires were included in both groups. The heritability of milk yield (MY), milk fat yield (FY) and 4% fat corrected milk yield (FCM) were investigated in standard lactation. Prior to the investigation of heritability, we examined frequency distribution normality of yield traits (Kolomogorov-Smirnov test) and homogencity of variance effects included in the model (Levene test). Since distributions of frequences were normal and variances were homogeneous, the mixed model of least squares was applied for the evaluation of heritability (Harvey 1987):

$$Y_{ijk} = \mu + O_i + FGS_j + b_1(x_1 - \bar{x}_1) + b_2(x_2 - \bar{x}_2) + e_{ijk}$$

Y_{ijk} = expressiveness of investigated trait in k-th cow, daughter of i-th sire in j-th farm-year season;
μ = overall mean;
O_i = random influence of i-th bull-sire;

FGS_j = fixed influence of j-th farm-year-season;

$b_1(x_1-\bar{x}_1)$ = linear regression influence of the age at the first calving (AC);

$b_2(x_2-\bar{x}_2)$ = linear regression influence of service period duration, days (DO);
e_{ijk} = random error.

Heritability was established by the method of intraclass correlation between half-sisters per sire, the ratio of additive genetic variances between and within groups being 0.25 : 0.75.

RESULTS AND DISCUSSION
Despite approximately equal raising conditions on the farms, the management of the farms conditioned the differences in milk production (Table 1). Although the t-test proved highly significant differences (P<0.01) in the rate of HF genes, their influences on the expressiveness of yield traits was not significant (P>0.05) in both samples, However, there was tendency towards increase of milk, milk fat and 4% fat corrected milk yields along with the increase of the rate of HF gene.

Table 1. Mean values and variability of the investigated traits

Traits	Group A (n=1400) $\bar{x}$	SD	CV(%)	Group B (n=1547) $\bar{x}$	SD	CV(%)	T-test P
HF,%	53	13.5	25.5	50	13.2	26.4	< 0.01
MY,kg	6087	1020.2	16.8	5702	1031.4	18.1	< 0.01
FY,kg	236	38.6	16.4	217	38.6	17.8	< 0.01
FCMY,kg	5972	979.0	16.4	5540	979	17.7	< 0.01
AC, day	782	65.5	8.4	777	64.5	8.3	< 0.01
DO, day	115	53.5	46.5	112	49.4	44.1	> 0.05

The differences in the age at calving were highly significant (P<0.01) in the observed groups, as well as in the effect of the age at calving on the expressiveness of the investigated traits. Each day's progression in the age at calving resulted in the increase of milk yield in standard lactation by 1.7 kg, milk fat yield by 0.07 kg, and 4% FCM yield by 1.8 kg in Group A, while in Group B these increases were by 2.7 kg, 0.10 kg and 2.6 kg. Like the age at calving, the duration of service period influenced the expressiveness of the investigated traits in both groups (P<0.01), although the difference in average duration (3 days) was statistically insignificant (P>0.05). According to the order of traits, in Group A the prolonged service period for 1 day produced increase in yields amounting to 4.1 kg, 0.15 kg and 3.9 kg, and in Group B 4.6 kg, 0.16 kg and 4.2 kg. The results obtained show that the rate of HF gene, age at calving and duration of service period cannot be ranked among the more dominated causes of differences in yield traits in two groups investigated. Lower relative variability of yield traits in standard lactation in the group with higher milk production, although the absolute variabilities were approximately equal in both groups, points to a significant environmental effect on yield, thereby on their heritability too. Lower heritabilities (Table 2) were found on the farms with lower milk yields. and they were by 50% lower than on the farms with higher milk yields

Table 2. Heritability of yield traits in standard lactation

Traits	Group					
	A			B		
	h^2	Sh^2	σ^2a (%)	h^2	Sh^2	σ^2a (%)
MY	0.208	0.076	5.19	0.093	0.045	2.32
FY	0.194	0.073	5.14	0.093	0.045	2.31
FCMY	0.202	0.075	5.16	0.095	0.045	2.38

Better conditions of animal raising provide for better genetic expressiveness. This contributes to the increase of additive variance and decrease in error variance, which results in higher heritability of the investigated traits. Lower heritabilites of milk fat yield are partially caused by long-term, selection and use of bulls for artificial insemination that were primarily selected for their superiority in milk yield, while the superiority in milk fat content was within the relatively narrow range (3.6-3.8%). Considering the variability of milk production, the results obtained are in accordance with the results and conclusions established by, Tempelman and Burnside (1990), Wiggans and Van Raden (1991), while the investigations of heritability comply with the results obtained by, Boldman and Freeman (1990) and Lazarevic *et al.* (1994).

CONCLUSION

Environmental effects, first of all determined by the management itself, i.e., by the level of production, when the other effects are mainly uniform, results in the changes of additive genetic variance expressiveness, thereby in heritability too. Under more favourable conditions, genotypes can be better expressed. This leads to the reduction of possibility of error making in the investigations, i.e., to the increase of additive genetic variance and heritability, which provides better quality of selection activities.

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