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Data on the Reduction in Improving Effect of A.I. Bulls in Relation to the Genetic Trend of the Population

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Summary. In order to clarify the question of the reduction in improving effect of A.I.bulls in relation to the genetic trend of the population, the authors have carried out two model calculations: a) This one assumed different genetic progress as well as different improving effects of bulls. The duration and extent of improving effect have been examined. b) The data on an US-Holstein-Friesian elite population was processed to determine changes in improving effect during a period of 10 years, assuming 1 per cent genetic gain per year. Ten per cent of this elite population were chosen and examined as a 'nucleus population'.

Conclusions are as follows: 1. In female populations representing continuous and considerable genetic progress, even bulls of excellent genetic merit can assure improvement for only a few years. 2. The improving effect may be referred to a definite population only if the progeny test results are directly related to the average of the population, or if these can be adjusted properly. 3. A 'nucleus population', selected and maintained by high selection pressure, could have such a great genetic superiority that progress is assured for a long time in the 'population with high breeding value'. 4. A significant genetic advance has to be achieved, maintained and utilized in the sire-producing mating category. This requires reasonable rationalization of selection and mating, utilizing international gene-resources and continuous control of the breeding value of sires in the populations.

Key words: Improving effect – A.I. bulls – Genetic trend – Breeding value – Milk production

Introduction

The improving effect of A.I. sires shows a continuous decrease. The term of improving effect depends on both the extent of improving effect and the extent of genetic progress of the female population. The improving effect of a given bull stud is therefore relative in time and space. Robertson (1979) calls attention to the fact that in general the genetic progress realized amounts to only about half the theoretically expected genetic gain. This might be explained first of all by the number of progeny tested bulls not being optimal relative to those of the A.I. ones and by insufficiencies in the selection of the bull-dams and sires of young bulls. Another reason could be that the average age (generation interval) of the mothers of young sires and of the sires of young bulls is higher than that taken into account by theoretical estimations.

According to Van Vleck (1977), the relatively small extent of realized genetic progress may be attributed to the fact that traits not directly connected with production (breeding aim) are highly overestimated in selection. In estimating the breeding value of bulls, the judgement of later production records of cow-progenies is exaggeratedly taken into account, greatly increasing the generation interval.

Akahori and Mitsumoto (1977) report that the more sires replaced by young bulls, the greater the possibility of genetic progress. About 80 per cent of the genetic improvement in the population may be attributed to selection among young sires.

It is clear that the assertion of modern population genetic principles is essential in breeding programs. By using pure breeding, genetic progress of 1-2 per cent per year may optimally be taken into account for milk production (Lindström 1969; Skjervold 1974; Robertson 1979). A decisive role is played by the mating category of the mothers of young sires as well as the sires of young bulls. This can account for upto 70-75 per cent of the genetic progress (Franz et al. 1974, cited by Dohy 1979).

With the development of international integration of breeding work – and because of the continuous genetic gain in milk production – the repeated supervision of the estimated breeding value of sires represents a permanent task. From this point of view it is important to compare

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the breeding values with the breed average. It is remarkable that, in the US-Holstein-Friesian breed, it has been found (Dawis 1976, cited by Dohy 1979) that when the progeny test result surpasses the repeatability of 70 per cent and +300 kg milk, the breeding value of the bull exceeds the average of the breed by a probability of 99 per cent. This statement should also be reviewed periodically with respect to the genetic trend in the population. Averdunk (1975) suggests a simple method of correcting the results to make it possible to compare the breeding values estimated in various years. In his opinion, the simplest way is to subtract the value of the genetic trend from the current estimate of breeding value.

Material and Methods

Based on conclusions of the literature and on the practice in modern breeding schemes, two model calculations were carried out to clarify the question discussed above.

a) In the first model calculation, it was assumed that the improving effect of sires (milk kg/year) amounts to 1-5 and 10 per cent, and the genetic trend in the female population amounts to 0.5, 1.0, 1.5 and 2 per cent of milk quantity per year. The duration and extent of improving effect of bulls having different genetic merit, concerning populations representing different genetic progress, have been demonstrated. The calculations were based on a population of 4000 kg FCM.

b) In the second model calculation, data from an actual population were processed, that of 44 bulls of the highest breeding value from a population of 887 Holstein-Friesian bulls, published by 'New USDA-DHIA Active A.I. Sire Summary List of Sept. 1976'. The progeny records of the selected 44 sires represented a population with high breeding value. Furthermore, 4 best sires from this stud list were chosen as a nucleus population.

The average production of the progeny groups of bulls and of their contemporaries served as a basis for the calculations. Assuming a genetic progress of 1 per cent per year in the female population it was demonstrated to what extent:

– the improving effect of sires would change in 10 years in the population with high breeding value;

– the breeding value of sires used in the nucleus population would change in 10 years, and

– the genetic superiority of the nucleus population would manifest itself compared to a population with high breeding value.

Results and Conclusions

Results of the calculations are summarized in Figure 1 a-d and in Tables 1 and 2 (the broken line marks the margin between superiority and inferiority of bulls for the appropriate genetic progress of the female population). It may be stated that the average abilities of the population can be even increased by sires having an improving effect of at least +3 per cent for only a few years.

It must be remarked that the improving effect may be referred to the definite population only if the progeny test results are directly related to the average of the population, or if these can be adjusted properly.

In the case of a genetic gain of 1 per cent per year the increase in milk production over a 10 year interval was practically linear. Within this period the cumulative effect of the genetic trend scarcely asserted itself.

In the population with high breeding value – in which the average improving effect amounted to +500 kg milk – the superiority of the sires after 5 years diminished to zero.

A nucleus population selected and maintained by high selection pressure could have such a great genetic superiority (Table 1) that progress is assured in the population with high breeding value for a long time (10-20 years).

Establishing improvement and differentiation of the nucleus population according to breeding aims (Hinks 1978) in accordance with our findings is of key importance because:

– the international integration of breeding work is being emphasized more and more extensively;

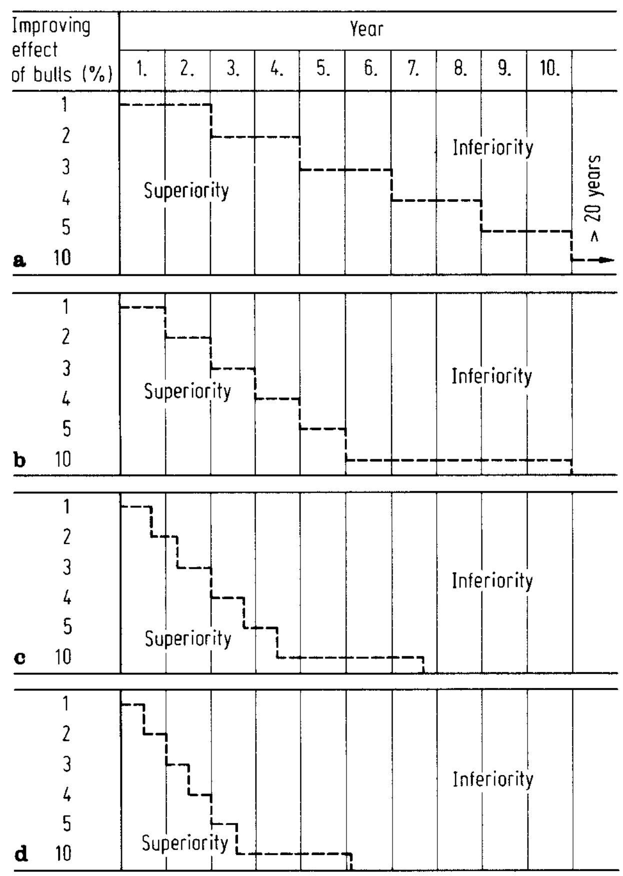

Fig. 1a-d. Changes in improving effect of bulls with different breeding values depending on the genetic progress in the population. **a** Genetic progress in the female population of 0.5% per year, **b** 1.0% per year, **c** 1.5% per year and **d** 2% per year

Table 1. Improving effect (milk kg) of bulls with a high breeding value in 'elite USA-Holstein-Friesian' populations in the case of 1 per cent genetic progress per year

Denomination	At the beginning	After 1	2	3	4	5	6	7	8	9	10 Years
Population with high breeding value[a]											
– Average milk production of cows, kg	7300	7373	7447	7521	7596	7672	7749	7826	7904	7983	8063
– Improving effect of bulls, milk kg	+500	+427	+353	+279	+204	+128	+ 51	– 26	–104	–183	–263
Nucleus population[b]											
– Average milk production of cows, kg	8200	8282	8364	8448	8533	8618	8704	8791	8879	8968	9058
– Improving effect of bulls, milk kg	+700	+618	+536	+452	+367	+282	+196	+109	+ 21	– 68	–158

a Data of 44 bulls with highest breeding value form the total 887 Holstein-Friesian bulls reported in the 'New USDA-DHIA Activa AI Sire Summary List of Sept. 1976'

b The 4 best bulls (10%) form the 44 bulls mentioned above

Table 2. Improving effect of bulls with a high breeding value in per cent in 'elite USA-Holstein-Friesian populations' in the case of 1 per cent genetic progress per year

Denomination	At the beginning	After 1	2	3	4	5	6	7	8	9	10 Years
Population with high breeding value[a]											
– Average milk production of cows, per cent	100.0	101.0	102.0	103.0	104.0	105.1	106.1	107.2	108.3	109.4	110.4
– Improving effect of bulls in per cent of milk kg	+6.8	+5.8	+4.8	+3.8	+2.8	+1.7	+0.7	–0.4	–1.4	–2.5	–3.6
Nucleus population[b]											
– Average milk production of cows in per cent of milk kg	100.0	101.0	102.0	103.0	104.1	105.1	106.1	107.2	108.3	109.4	110.5
– Improving effect of bulls in per cent of milk kg	+8.5	+7.5	+6.5	+5.5	+4.5	+3.4	+2.4	+1.3	+0.3	–0.8	–1.9

a Data of 44 bulls with highest breeding value from the total 887 Holstein-Friesian bulls reported in the 'New USDA-DHIA Active AI Sire Summary List of Sept. 1976'

b The 4 best bulls (10%) form 44 bulls mentioned above

– up-to-date technics (incl. biotechnics), the concentration of selection bases, as well as the modern organization of breeding work will accelerate genetic progress.

Taking all these statements into consideration, a significant genetic advance has to be achieved, maintained and utilized in the sire producing mating category. This demands reasonable rationalization of selection and mating, utilization of international gene-resources and continuous control of the breeding value of sires in the populations.

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