Analysis of genetic progress in the Hungarian Sport Horse population

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Abstract
The aim of the study was to analyse the genetic response in performance tests of the Hungarian Sport Horse mares based on the test results of 435 three-year-old, and 240 four-year-old mares from 1993 to 2004. Conformational traits, free jumping performance and movement analyses were scored on the tests. Breeding value estimation was based on BLUP AM. Test year, age and owner were included in the animal model as fixed effects. The breeding values showed significant positive genetic progress for every trait. Higher genetic progress was achieved for type, impulsion and elasticity of movement and canter traits. The stallions' breeding values rarely exceeded the average with two standard deviations.

Keywords: genetic progress, selection intensity, horse breeding, sport horse

Introduction

The BLUP method was used first by Árnason (1980) in horse breeding for Icelandic Toelter horses. Utilization of this method spread very quickly. Tavernier (1988) wrote about the application of BLUP procedures in France and there was some information from the Swedish adaptation in Philipsson's (2005) study. A German breeding estimation method developed by Meinardus (1988) is based on show jumping and dressage results. The results of further German works and developments for estimation methods can be found in Kalm (1997), Bugislaus et al. (2004), Lührs-Behnke et al. (2005) and Velsen-Zerweck – Bruns (1998) studies.

For the improvement of breeding value estimation in Hungary, the application and correction (if it is necessary) of widely used methods is needed. Our analysis was done in correspondence with The Association of Hungarian Horse Breeders and Horse Organization and The Association of Hungarian Sporthorse Breeders (MSLT). The aims of the study were breeding value estimation and the assessment of genetic progress for the evaluated traits in performance test of Hungarian Sporthorse mares

Materials and Methods

The data set used for the analysis was supplied by MSLT. Test records of three-year-old and four-year-old mares from 1993 to 2004 were analyzed. There were 435 records from 3-year-old and 240 records from 4-year-old mares, respectively. Seventy-nine mares were tested at both ages.

The mare performance test consists of conformation judgement, free jumping and movement analysis.

Traits judged at mare performance test:
Conformation traits: type, head, neck, saddle region, frame, forelimbs, hind limbs, regulatory of movement, impulsion and elasticity of movement, overall impression.
Free jumping: jumping style, jumping ability–sense of distance; observation during training.
Movement analysis: walk, trot, canter, overall impression, test rider's score. (MSLT, 2000)

The scores of free jumping and movement analysis traits were scored between 0 and 10. Conformation traits were judged by weighting the riding horse qualities since 2000. Weighted traits (neck, forelimbs, hind limbs and impulsion and elasticity of movement) were scored in a 0–12 scale. Type (0–6), head and frame (0–8) were judged in a smaller interval. Observation during training (one of the free jumping traits) was scored by the trainer. Test rider's score was given by the test rider based on the ridability of the horse. Other traits were scored by the invited judge. The final score of mare test contains the mean of the conformation score, the mean of free jumping performance scores and the mean of movement analysis scores multiplied by 1, 1.5, and 2, respectively (MSLT, 2000).

The pedigree used for the analysis contained ancestors of participating mares at least 3 generations back. Variance components needed for this analysis were taken from Posta and Komlósi's study (in press). Breeding values were estimated with PEST (Groeneveld et al., 1990) for each trait using the following model:

$$Y_{ijklm} = \mu + Year_i + Age_j + Owner_k + Animal_l + e_{ijklm}$$

where Y_{ijklm} = m–th score of l.-th mare; μ = the population mean; $Year_i$ = effect of mare test's year (1993-2004); Age_j = effect of age class (3, 4); $Owner_k$ = effect of owner; $Animal_l$ = random effect of l-th mare; e_{ijklm} = random residual term. (Posta and Komlósi, in press)

Including the breeder in the model made no significant improvement, so its inclusion is not necessary. Breeding values were presented with the mean 100 and standard deviation of 20 Koenen (2005). Reliability was computed based on the estimated error variance for every trait in the case of each animal. For the determination of the genetic progress, breeding values were sorted into groups based on the animal's birth year and data were evaluated with analysis of variance and regression analysis with SAS PROC MEANS and SAS PROC REG (1999).

The selection intensity was calculated by dividing the selection response with the heritability and genetic standard deviation.

Results and discussion

Figure 1 shows the breeding values of some stallions with the most offspring in mare performance tests from the last 10 years. These predicted values show the effect of the stallions compared to the present registered stock. Figure 1 also shows the reliability of the estimated breeding values for every traits in the case of every stallion.

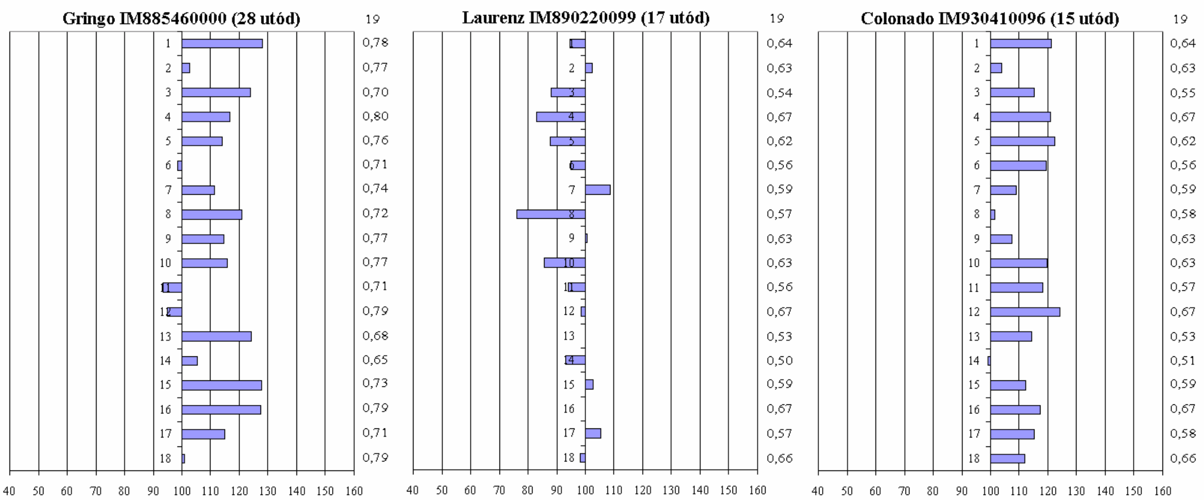

Figure 1: Breeding values of some stallions with the most daughters participating in mare performance tests Type (1), Head (2), Neck (3), Saddle region (4), Frame (5), Forelimbs (6), Hindlimbs (7), Regularity of movement (8), Impulsion and elasticity of movement (9), Overall impression (10), Jumping style (11), Jumping

ability y(12), Observation during training (13), Walk (14), Trot (15), Canter (16), Overall impression (17), Test rider's score (18); Reliability (r^2) (19)

Colonado seems to be an overall positive stallion, because of its breeding values are above average for every trait. The stallion, named Gringo has a good corrective effect on most of the parameters taken into account on mare performance tests because the presented breeding values are more than one standard deviation above the mean (100) of the stock. The breeding values of Laurenz are negative in most of conformation traits and in jumping style and walk. If the regularity of movement is focused, this stallion belongs to the worst 16% of the population based on the breeding value.

It is important to emphasize that notable progress could be expected in a trait only with the preference of stallions (and offspring of these stallions) whose breeding values approximate to the three standard deviation, but at least one standard deviation greater than the population mean.

Figure 2 shows the genetic progress of conformation traits. Genetic progress of free jumping performance traits and movement analysis traits are shown in Figure 3.

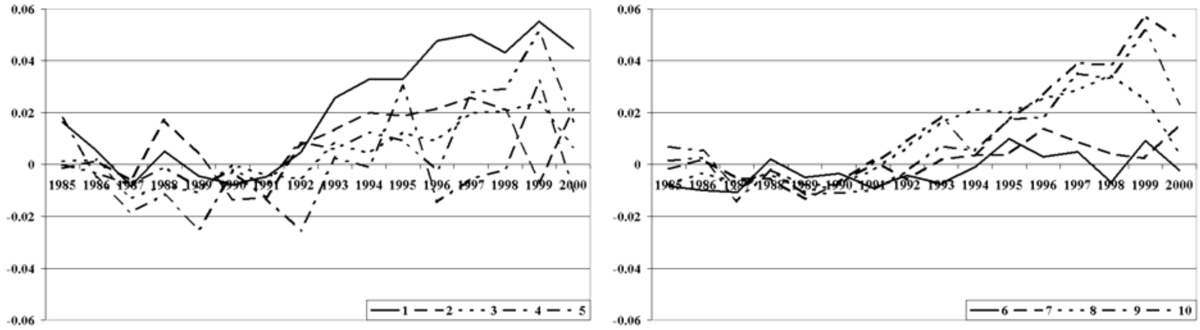

Figure 2: Genetic progress in conformational traits evaluated in mare performance tests
Type (1), Head (2), Neck (3), Saddle region (4), Frame (5), Forelimbs (6), Hindlimbs (7), Regularity of movement (8), Impulsion and elasticity of movement (9), Overall impression (10)

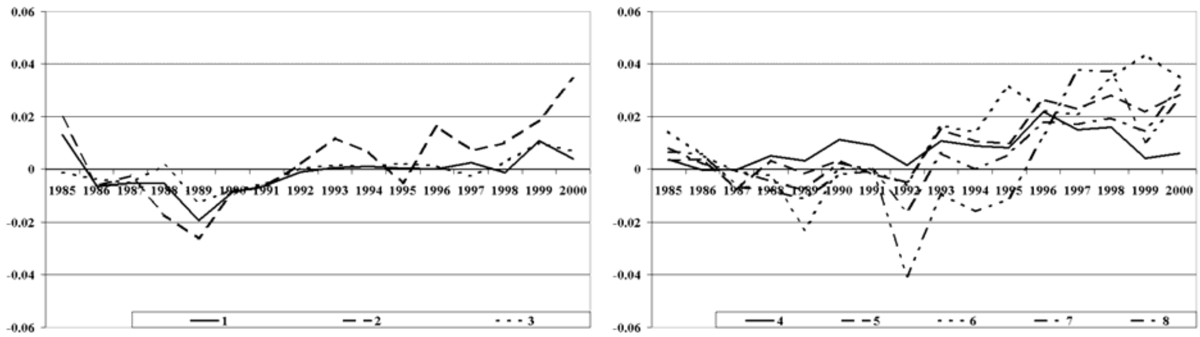

Figure 3: Genetic progress in free jumping performance and movement analysis traits evaluated in mare performance tests
Jumping style (1), Jumping ability (2), Observation during training (3), Walk (4), Trot (5), Canter (6), Overall impression (7), Test rider's score (8)

Yearly progress was computed from the yearly mean of breeding values. The statistical analysis of data showed significant ($P<0.05$) progress for every trait. Table 1 shows the estimated coefficient (b-value) of the regression line with the level of significance and the selection intensity for every trait. Highest progress can be seen in the case of type (b=0.0024) and impulsion and elasticity of movement (b=0.0024) in conformation traits. The selection intensity was more accurate for the overall impression of conformation, and intensity was also high for type and impulsion and elasticity of movement.

In free jumping performance there are high progress and selection intensity for jumping ability (b=0.0017). The regression coefficient for canter (b=0.0022) was the highest among the movement analysis traits. Selection intensity was high for overall impression of movement analysis and canter. Progress was smallest for frame (b=0.0004), observation during training (b=0.0004) and walk (b=0.0005) from the three traits groups, respectively. Selection intensity showed similar results with the values of 0.00103, 0.00199 and 0.00254, respectively.

The regression coefficients showed positive progress in the case of every evaluated conformation trait despite the results of Árnason (1987) study, which was based on data between 1973 and 1979. For gaits and jumping ability there were higher regression coefficients in Árnason (1987) study (b=0,0008 és b=0.0012). The genetic progress was similar to the results published by Philipsson (2005).

Table 1: Traits, and genetic gaining of traits

Trait	h^2	σ_g	Selection intensity	Regression coefficient	Level of significance
Type	0.45	0.65750	0.00544	0.0024	<0.0001
Head	0.42	0.60225	0.00307	0.0012	<0.0001
Neck	0.28	0.47262	0.00480	0.0012	<0.0001
Saddle region	0.53	0.74899	0.00110	0.0006	0.0424
Frame	0.40	0.61543	0.00103	0.0004	<0.0001
Forelegs	0.30	0.44083	0.00248	0.0006	0.0024
Hind legs	0.35	0.54456	0.00497	0.0016	0.0003
Regularity of movement	0.32	0.41485	0.00511	0.0012	<0.0001
Impulsion and elasticity of movement	0.43	0.66078	0.00554	0.0024	<0.0001
Overall impression	0.43	0.54269	0.00590	0.0021	<0.0001
Jumping style	0.29	0.54891	0.00237	0.0007	<0.0001
Jumping ability	0.52	0.77398	0.00305	0.0017	<0.0001
Observation during training	0.32	0.35537	0.00199	0.0004	<0.0001
Walk	0.22	0.41968	0.00254	0.0005	<0.0001
Trot	0.36	0.46308	0.00468	0.0013	<0.0001
Canter	0.51	0.64445	0.00478	0.0022	<0.0001
Overall impression	0.33	0.43344	0.00522	0.0013	<0.0001
Test rider's score	0.51	0.72794	0.00365	0.0019	<0.0001

Conclusion

The estimated breeding values did not exceed the mean with more standard deviation, so the preference of positive stallions had only a slow progress.

To improve the reliability of the estimated breeding values, the evaluation of more offspring would be necessary in the performance tests.

Remarkable genetic progress was achieved in the traits type, impulsion and elasticity of movement and canter.

There is significant genetic progress in the evaluated traits of Hungarian Sport horse based on the results of mare performance tests.

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