HERITABILITIES OF LINEAR TRAITS OF THE LIMOUSIN SIRE CANDIDATES IN HUNGARY

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SUMMARY

The aim of this study was to estimate the effects of environmental factors on 16 type traits and estimate heritabilities of the traits and their phenotypic correlations with the total phenotypic score. Type scores of 782 animals were collected in one Limousin seedstock herd sired by 27 bulls between years 1992 and 2005. Sire candidates of 12 months old were officially qualified at the end of the performance test. Year of birth affected all tested traits (P<0.001), month of birth affected most of the traits (P<0.05). Very strong correlations (from 0.84 to 0.91, P<0.001) were observed between total phenotypic score and the 16 linear traits. Heritabilities were very low for shoulder stability, strength of back and rump and muscularity of shoulder. The highest h^2 was calculated for loin width (0.32). The results indicate that it is possible to integrate linear traits into the Hungarian animal model to estimate the breeding values of Limousin sire candidates in Hungary.

Key words: *Limousin, bulls, heritability, type traits.*

INTRODUCTION

The connection between phenotype and expected progeny difference is stronger in meat production traits than in other traits. The heritability of visually assessed beef traits are relatively high (h^2 = 0.4 - 0.6). A correlation (0.70<=) exists between muscularity and slaughter traits, that establishes the application of type classification in practice (Korchma, 1986; Journaux, 1994). Therefore, it is a particular and definite role of type-classification results - to assure an efficient selection - in breeding programmes of beef cattle breeds.

The type-classification introduced in 1986 in Hungary, was based on four principal quality groups (utility score, score for length, score for width, score for muscularity) and included 22 type traits. Breeding Association of Limousin Breeders developed a classification system for cows and bulls (Balika and Bíró, 1993).

Performance tested bulls of 12 months of age were officially qualified at the end of the performance test (PT). Live weight adjusted to 400 days of age was considered

to weigh 40 % in the sire qualifying index. The corresponding weighing for height at withers:10%, length:15%, width:10%, muscularity:15% (Balika and Tőzsér ,2001).

Factor analysis was used to study the relationships between type traits assessed in the former type-classification system in Holstein-Friesian cows (Sieber *et al*., 1988), in Hereford cows (Márton *et al*., 1988) and in Limousin cows (Vági, 1992). Tőzsér *et al*. (1998) established an estimation method for the type traits including 327 Charolais sire candidates. Group of traits on utility value showed a considerable heterogeneity. Namely, in the group of traits consists of six part traits: the shoulder stability - strength of back and rump (III, 10.7 %) and leg structure - skeleton (IV, 10.4 %) factors could be separated clearly. The results of multiple regression analysis (backward stepwise) indicated that it is possible to reduce the number of 22 type traits in type classification systems of Limousin sire candidates (Tőzsér *et al*. 1998).

The aim of this study was to estimate the effects of environmental factors on 16 type traits and estimate the heritabilities of the traits and their phenotypic correlations with the total phenotypic score in Limousin sires in Hungary.

MATERIAL AND METHODS

Conformation scores of 782 animals were collected in one Limousin seedstock herd. The animals were the progenies of 27 sires, born between 1992 and 2005. Sire candidates of 12 months old were officially qualified at the end of the performance test. Four trait groups were formed, including four traits in each.

Group I: height at withers, chest depth, shoulder stability, strength of back and rump

Group II: length of the body, length of the back, length of the loin, length of the rump

Group III: width at withers, chest width, loin width, rump width I

Group IV: muscularity of breast, muscularity of shoulder, muscularity of back, muscularity of rump.

The bulls were scored on the 1-9 point scale according to Balika and Bíró (1993). In this modified classification system 1-3 points mean the undesirable and ≥ 4 points the excellent stature. The present scoring system described in the Breeding Programme of the Breeding Association of Limousin Breeders (Balika and Tőzsér 2001).

Recorded data were analysed using the programme SAS version 9.1 (SAS Institute Inc., 1999). Environmental effects such as year of birth, month of birth and their interaction in addition to the animal effect were analysed by the following model for each trait.

$$Y_{ijkl} = Year_i + Month_j + Year_i*Month_j + Animal_k + e_{ijkl},$$

Where, Y_{ijkl} = score of the bull; $Year_i$ = effect of year of birth of the *i*th bull; $Month_j$ = effect of the *j*th month of birth of the *i*th bull; Year*Month= interaction between year and month; $Animal_k$ = random effect of the k_{th} individual, e_{ijkl} = residual error.

Only one generation pedigree data was available. The genetic parameters and variance components were estimated by VCE-5 (Kovac and Groeneveld, 2003) software package.

RESULTS AND DISCUSSION

Phenotypic scores of evaluated Limousin bulls (mean and SE values) are summarized in Table 1. The average total score (TS) exceeded the "good" (>61 points) standard performance.

Table 1.Type-classification scores of Limousin bulls (n=782)

Traits	Mean ± S.E.
Height at withers	5.58±0.04
Chest depth	5.96±0.04
Shoulder stability	6.45±0.03
Strength of back and rump	6.66±0.04
Length of the body	5.94±0.04
Length of the back	5.95±0.05
Length of the loin	5.94±0.04
Length of the rump	5.71±0.04
Width at withers	5.55±0.04
Chest width	5.85±0.04
Loin width	5.99±0.04
Rump width I	5.83±0.04
Muscularity of breast	5.68±0.05
Muscularity of shoulder	5.87±0.05
Muscularity of back	6.05±0.05
Muscularity of rump	5.85±0.05
Total score	65.11±0.43

The average score of the 16 linear traits are close to 6 or above. In this system 5-6 points are considered to be an excellent stature.

The significance of environmental effects on linear traits is given in Table 2. The year of birth significantly affected all the traits ($P<0.001$). The month of birth showed no significant effect ($P>0.05$) on height at withers, shoulder stability, length of the body and on length of the back. The year and month interaction has an effect ($P<0.05$) only on height at withers, strength of back and rump, length of the back. Coefficients of determinations (R^2) are also shown in Table 2. The value of R^2 varied from 0.30 to 0.38 suggesting that there are other factors potentially affecting these traits are not accounted for by the model. Usual environmental factors in beef models analysing weaning traits include age of dam, age of calf, and season. The influence of the previous two factors though diminishing by age like in our case, where the bulls were one year of age.

The phenotypic correlations between the TS and the 16 linear traits are presented in Table 3. The correlations varied between 0.55 (strength of back and rump) and

0.99 (muscularity of breast) with the TS. Moderate correlation was only observed for shoulder stability (r=0.69) and for strength of back and rump (r=0.55). All of the other traits were highly correlated with TS, indicating their necessity in the conformation assessment to improve selection for high TS.

Table 2. The environmental effects on linear traits and R^2 of the model

Traits	Year	Month	Year*Month	R^2
Height at withers	***	ns	*	0.35
Chest depth	***	*	ns	0.30
Shoulder stability	***	ns	ns	0.33
Strength of back and rump	***	*	***	0.43
Length of the body	***	ns	ns	0.34
Length of the back	***	Ns	*	0.34
Length of the loin	***	**	ns	0.33
Length of the rump	***	*	ns	0.35
Width at withers	***	*	ns	0.38
Chest width	***	*	ns	0.38
Loin width	***	***	ns	0.35
Rump width I	***	*	ns	0.33
Muscularity of breast	***	*	ns	0.35
Muscularity of shoulder	***	*	ns	0.38
Muscularity of back	***	*	ns	0.31
Muscularity of rump	***	*	ns	0.31

*=P<0.05, **=P<0.01, ***=P<0.001, ns =non-significant

Table 3. Phenotypic correlations between the total score (TS) and 16 linear traits (n=782)

Traits	Phenotypic correlations (r)
Height at withers	0.84
Chest depth	0.82
Shoulder stability	0.69
Strength of back and rump	0.55
Length of the body	0.88
Length of the back	0.84
Length of the loin	0.84
Length of the rump	0.88
Width at withers	0.89
Chest width	0.88
Loin width	0.89
Rump width I	0.87
Muscularity of breast	0.91
Muscularity of shoulder	0.91
Muscularity of back	0.90
Muscularity of rump	0.86

In all cases the $P < 0.001$.

Heritability estimates are summarized in Table 4. The heritabilities were very low for shoulder stability, strength of back and rump and muscularity of shoulder. The highest h^2 was calculated for loin width (0.32). The heritabilities obtained in this study are lower than that calculated by Vági (1994) for Limousin cows (utility score: h^2 =0.36-0.78, muscularity: h^2 =0.36-0.76), by Fouilloux *et al*. (1997) for Limousin bulls (muscularity: h^2 = 0.56), and by Journaux (1994) four French beef breeds (muscularity: h^2 =0.35). The tendency between the calculated heritabilities for the traits follows the known tendency that is the heritability for scores on "bone" traits, such as height, are in the higher end, and values for muscularity traits are in the lower end. The heritabilities are calculated in one herd, while the higher values in the studies presented are calculated in a population consisting of several herds, where the genetic variation might be larger.

Some of the heritabilities in the present study though have high standard errors, which points to the necessity to increase precision and the depth of the pedigree data.

Table 4. Heritability values of the investigated traits

Traits	Heritability (h^2)	Standard error of estimation
Height at withers	0.15	0.126
Chest depth	0.13	0.074
Shoulder stability	0.01	0.001
Strength of back and rump	0.06	0.062
Length of the body	0.20	0.088
Length of the back	0.10	0.072
Length of the loin	0.21	0.088
Length of the rump	0.02	0.038
Width at withers	0.21	0.089
Chest width	0.11	0.081
Loin width	0.32	0.091
Rump width I	0.15	0.085
Muscularity of breast	0.11	0.084
Muscularity of shoulder	0.04	0.054
Muscularity of back	0.10	0.074
Muscularity of rump	0.11	0.066

CONCLUSION

The averages of the type scores are 6 or above indicate the good quality conformation of the sire replacements. The studied traits are mainly strongly correlated with the total type score. Effective selection can be achieved on length of body, length of loin, loin width and width at withers. The standard errors of the heritability for the other traits are so high – probably due to the insufficient ancestral information-that recalculation is necessary after having accumulated substantial pedigree information.

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المكافئ الوراثى لصفات النموذج فى ذكور الليموزين المنسبة فى المجر

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الهدف من هذه الدراسة هو تقدير كل من العوامل البيئية المؤثرة على ستة عشر صفة للنموذج والمكافئ الوراثى لتلك الصفات بالإضافة إلى تقدير الارتباطات المظهرية لتلك الصفات مع الارتباط المظهرى الكلى للنموذج. أستخدم فى هذه الدراسة 782 ذكرا من أحدى قطعان الليموزين بالمجر والناتجة من 27 طلوقة خلال الفترة من 1992 الى 2005 . تراوح عمر تلك الذكور عام تقريباً.

أوضحت النتائج معنوية سنة الميلاد على جميع الصفات المدروسة على مستوى (0.001) وكذلك كان لشهر الميلاد تأثيرا معنويا على معظم صفات النموذج على مستوى (0.5). كذلك تراوحت قيم معاملات الارتباطات بين النموذج المظهرى الكلى و الستة عشر صفات للنموذج مابين (0.84 إلى 0.91).

كانت قيم المكافئ الوراثى منخفضة لصات استواء الأكتاف، استقامة كل من الظهر والكفل وعضلات الكتف. بينما كانت قيمة المكافئ الوراثى (0.32) لصفة محيط المنطقة القطنية.

كذلك أوضحت تلك الدراسة إمكانية استخدام صفات النموذج فى تقدير القيمة التربوية لذكور الليموزين المنسبة فى المجر باستخدام نموذج الحيوان.