

GENETIC TRENDS AND BREEDING VALUE STABILITY IN HUNGARIAN PUREBRED AND CROSSBRED MATERNAL PIG BREEDS

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SUMMARY

Authors analyzed genetic trends and the stability of breeding values in Hungarian purebred maternal pig breeds – Hungarian Large White (HLW), Hungarian Landrace (HL) – and their reciprocal cross (HLW x HL; HL x HLW) for age at first insemination (AFI), number of born alive piglets (NBA) and farrowing interval (FI). The analysis was based on the data collected by the Agricultural Agency of Administration in course of field tests between 2001 and 2010. Genetic parameters and breeding values were estimated by REML and BLUP methods using the VCE6 and PEST softwares applying a two-trait animal model. The records of the purebred and crossbred pigs were considered as separate traits. Genetic trends ranged for AFI between -1.57- -4.3 days/year, for NBA between 0.01-0.03 piglets/year and for FI between -0.36- -1.01 days/year. The common number of highest ranked pigs based on the purebred and crossbred breeding values for every trait as an indicator of stability of breeding values was high for NBA, and it ranged between low and high for AFI and FI. Calculating the differences between the crossbred breeding values of the pigs ranked once on the purebred and then on the crossbred breeding values there was only difference in AFI and FI. As a conclusion we found negligible changes in the genetic trends NBA and FI while in AFI the trend was important. The breeding values for NBA showed high stability but for AFI and FI the magnitude of stability was less.

ÖSSZEFOGLALÁS

Nagyné Kiszlinger Henrietta - Farkas János - Kövér György - Nagy István: GENETIKAI TRENDEK ÉS TENYÉSZÉRTÉK STABILITÁS A HAZAI FAJTATISZTA ÉS KERESZTEZETT ANYAI SERTÉSFAJTÁKBAN

Aszerzők a hazai anyai sertésfajták – magyar nagyfehér, magyar lapály – és a reciprok keresztezett utódok populációiban vizsgálták az első inszemináláskori életkor (AFI), az élve született malacszám (NBA) és a két fialás közti idő (FI) tulajdonságokban a genetikai trendet és a tenyészték stabilitást az MgSZH által 2001 és 2010 között gyűjtött adatok alapján. A genetikai paramétereket és a tenyésztékeket a REML és BLUP módszerrel a VCE6 és a PEST szoftver alkalmazásával kétváltozós egyedmodellel becsülték. A fajtatiszta és a keresztezett állatok teljesítményét külön tulajdonságként kezelték. AFI esetében -1,57- -4,3 nap/év javulást becsültek, NBA esetében a trend 0,01-0,03 malac/év, míg az FI tulajdonságban -0,36- -1,01 nap/év. A fajtatiszta és keresztezett tenyészték alapján rangsorolt legjobb állatok közös képviselőinek aránya mint a tenyészték stabilitásának mutatója az NBA tulajdonságban magas volt, az AFI és az FI tulajdonságokban azonban ez az arány az alacsonytól a magasig változott. A fajtatiszta, majd keresztezett tenyészték alapján rangsorolt állatok keresztezett tenyésztékei között csak az AFI és a FI tulajdonságokban tapasztaltak különbséget. Megállapították, hogy az NBA és FI tulajdonságokban a genetikai előrehaladás csekély mértékű, míg az AFI esetében jelentős. Az NBA tenyészték stabilitása nagy, míg az AFI és FI tulajdonságokban kisebb.

INTRODUCTION

Pig breeding is considered an important sector in Hungarian animal breeding due to the high pork consumption within total meat consumption rates. Thus the genetic potential of the Hungarian pig population has to continuously be improved by selection. The Hungarian pig breeding sector has applied the BLUP (Henderson, 1975) procedure since the mid 1990s but the selection is based on BLUP results since 2008 (MgSzH, 2009). Hybridisation is widely used in pig breeding thus breeders should also consider the crossbred breeding values of pigs instead of solely applying of purebred breeding values in case of low to medium association between purebred and crossbred performance. Differences between genetic trends of purebred and crossbred breeding values can justify the use of crossbred breeding values.

The aim of this paper was to estimate genetic trends and breeding value stability in Hungarian maternal pig population for reproduction traits such as age at first insemination (AFI), number of born alive piglets (NBA) and farrowing interval (FI) based on both the purebred and crossbred performances.

MATERIAL AND METHODS

The analysis was based on the data collected by the Agricultural Agency of Administration in the course of field tests conducted between 2001 and 2010. The analyzed breeds were the Hungarian Large White (HLW), Hungarian Landrace (HL) and their reciprocal cross (HLW x HL and HL x HLW). The total number of animals in the pedigree file was 138969.

Basic descriptive statistics were calculated applying SAS (SAS Institute Inc., 2004) (*Tables 1. and 2.*). Genetic parameters were estimated separately by REML method using the PEST (Groeneveld, 1990) (only for data coding) and VCE6 softwares (Groeneveld *et al.*, 2008) applying two-trait repeatability models for NBA, FI, and two trait animal model for AFI. The records were set to a missing value when not observed in the following intervals: for FI 139-290 days and for AFI 150-450 days. Altogether six runs were performed. The structure of repeatability model for NBA, FI, and the animal model for AFI (without matrix W_i and vector pe_i) was the following:

The crosses were split into 2 datasets (HLW– HLW x HL; HL – HLW x HL). The records of the purebred and crossbred pigs were considered as separate traits. The structure of the animal model was the following:

$$\begin{bmatrix} y_1 \\ y_2 \end{bmatrix} = \begin{bmatrix} X_1 & 0 \\ 0 & X_2 \end{bmatrix} \begin{bmatrix} b_1 \\ b_2 \end{bmatrix} + \begin{bmatrix} Z_1 & 0 \\ 0 & Z_2 \end{bmatrix} \begin{bmatrix} a_1 \\ a_2 \end{bmatrix} + \begin{bmatrix} W_1 & 0 \\ 0 & W_2 \end{bmatrix} \begin{bmatrix} pe_1 \\ pe_2 \end{bmatrix} + \begin{bmatrix} e_1 \\ e_2 \end{bmatrix}$$

where y_i = vector of observations for the i^{th} trait, b_i = vector of fixed effect for the i^{th} trait, a_i = vector of random animal effects for the i^{th} trait, pe_i = vector of permanent environmental effects for the i^{th} trait e_i = vector of residuals for the i^{th} trait and X_i , Z_i and W_i are incidence matrices relating records of the i^{th} trait to fixed effects, random animal effects and random common litter effects, respectively.

The variance-covariance matrices for the random additive genetic, random common litter and and residual effects were:

$$\text{var}[a] = G \otimes A, \text{ with } G = \begin{bmatrix} \sigma_{a1}^2 & \sigma_{a12} \\ \sigma_{a21} & \sigma_{a2}^2 \end{bmatrix}; \text{ var}[pe] = W \otimes I, \text{ with } W = \begin{bmatrix} \sigma_{pe1}^2 & \sigma_{pe12} \\ \sigma_{pe21} & \sigma_{pe2}^2 \end{bmatrix};$$

$$\text{var}[e] = R \otimes I, \text{ with } R = \begin{bmatrix} \sigma_{e1}^2 & \sigma_{e12} \\ \sigma_{e21} & \sigma_{e2}^2 \end{bmatrix}$$

where **A** is the numerator relationship matrix among the animals, **I** is an identity matrix, σ_{ai}^2 , σ_{pei}^2 and σ_{ei}^2 are additive genetic variance, permanent environmental variance and residual variance for trait *i*, σ_{aij} , σ_{peij} and σ_{eij} are corresponding additive genetic, permanent environmental and residual covariances between traits *i* and *j*.

Number of farrowing, farrowing year-month, herd, weaning year-month, inseminating year-month were considered as fixed effects, while additive genetic was assumed to be a random effect.

Genetic trends

Were based on the annual means of breeding values of the analysed traits linearly regressed on the years of birth using SAS (SAS Institute Inc, 2004). Genetic trends of purebred pigs were calculated on the basis of their purebred and crossbred breeding values for every trait, while genetic trends of crossbred pigs were calculated only based on their crossbred breeding values. Comparison of purebred and crossbred genetic trends was done according to Mead et al. (1993).

Stability of the breeding values

The HLW and HL purebred pigs were annually ranked for AFI, NBA and FI based on their purebred and crossbred breeding values. Stability of breeding values were characterized by the common representatives of the top 1000 sows based on the purebred and crossbred breeding values for every trait. Taking the top 1000 pigs based on the purebred and crossbred breeding values the difference of the breeding values using the crossbred breeding values of the same pigs were also calculated.

RESULTS

The descriptive statistics are shown in *Table 1*. The highest variability was found in the number of born alive piglets. To the minimum and maximum values of age at first insemination, gestation length and farrowing interval were set lower and upper limits so these values are equal in all genotypes. Viewing the means of the analyzed traits all three genotypes are close to each other except of AFI where significant differences were found in favour of the purebred HL. Crossbred pigs did not show superiority compared with both purebred genotypes in any of the traits.

Table 1.

Descriptive statistics for the genotypes for the traits measured

	Trait	Minimum	Maximum	Mean	SD	CV%
HLW	AFI ¹ (days)	154.0	450.0	278.8	45.7	16.4
HLW	NBA ²	1	25	10.3	2.6	25.2
HLW	FI ³ (days)	140.0	289.0	166.2	26.5	15.9
HL	AFI ¹ (days)	155.0	450.0	254.1	42.9	16.9
HL	NBA ²	1	22	10.5	2.6	24.8
HL	FI ³ (days)	140.0	289.0	161.0	23.8	14.8
HWLxHL; HLxHWL	AFI ¹ (days)	153.0	450.0	267.5	43.7	16.3
HWLxHL; HLxHWL	NBA ²	1	24	10.4	2.4	23.1
HWLxHL; HLxHWL	FI ³ (days)	140.0	289.0	162.1	23.9	14.7

¹ age at first insemination, ² number of born alive piglets, ³farrowing interval

1. táblázat A vizsgált genotípusok leíró statisztikája a mért tulajdonságokban életkor első termékenyítéskor (1); élveszületett malacszám (2); ellési intervallum (3)

Estimated genetic trends are presented in *Table 2*. We found significant favourable trends in age at first insemination both in purebred and crossbred pigs (-1.57 – -4.3 days/year). Contrary to our results *Imboonta et al. (2007)* estimated a value of 0.23 in Thai Landrace pigs. There is no more relevant literature available hence further analyse are needed. The genetic change of number of born alive piglets was small with a range between 0.01 and 0.03. Other authors established similar trends. *Kaplon et al. (1991)* studied Polish Large White pigs and estimated a genetic trend of 0.01 pig/year. *Ferraz and Johnson (1993)*, *Chen et al. (2003)* and *Chansomboon et al. (2010)* showed similar results. We also found negative trends in the literature. *Zhang et al. (2000)* found in composite pig population a genetic change of -0.02 pig/year, while *Kasprzyk (2007)* got for Polish Landrace -0.05 pig/year. Our genetic trends in farrowing intervals were favourable in all breeds (-0.36 – -1.01 days/year). Other authors analysed the interval from weaning to service thus we can not compare our findings with those of others. Significant differences between purebred and crossbred genetic trend of purebred sows could only been found in the genotype HLW in the traits AFI, NBA and FI.

The common number of highest ranked pigs based on the purebred and crossbred breeding values (*Table 3*) was medium and unbalanced for HLW in AFI while for HL it was medium to high. In the trait NBA the stability of breeding values was high for each genotype. The common number of sows in the trait FI was a bit higher for HLW sows. In the dataset for HL there were less than 1000 sows in the year 2010 thus the common representatives were obviously 100 %. According to our best understanding no similar references were available to compare our results. If the percentage of common representatives is medium or low it means that there is a substantial difference between the purebred and crossbred breeding value of the same animal.

Table 2.

Genetic trends of the analyzed traits (standard errors are in brackets)

Genotype	AFI (days/year)		NBA		FI (days/year)	
	pBV ¹	cBV ²	pBV	cBV	pBV	cBV
HLW	-2.61 (0.24) a	-1.64 (0.12) b	0.03 (0.005) a	0.02 (0.003) b	-0.84 (0.05) a	-0.63 (0.04) b
HL	-1.59 (0.45) a	-1.57 (0.39) a	0.01 (0.003) a	0.02 (0.003) a	-0.38 (0.02) a	-0.36 (0.06) a
HLW x HL	-	- 4.30 (0.42) - 4.20 (0.43)	-	0.01 (0.002) 0.01 (0.002)	-	-1.01 (0.08) -0.92 (0.09)

1 – purebred breeding value; 2 – crossbred breeding value, * not significant ($p < 0,05$)

Trends with different characters are significantly different ($p < 5\%$)

2. táblázat A vizsgált tulajdonságok genetikai trendje (zárójelben a standard hiba) fajtatiszta tenyészték (1); keresztezett tenyészték (2)

Az eltérő betűkkel jelölt trendek szignifikáns mértékben különböznek ($p < 5\%$)

Table 3.

Common representatives of the top 1000 sows in different years expressing the stability of the breeding values for AFI, NBA and FI in maternal breeds (%)

	AFI		NBA		FI	
	HLW	HL	HLW	HL	HLW	HL
2001	64	92	93	99	78	62
2002	44	76	91	99	74	45
2003	48	76	91	99	70	52
2004	46	70	89	97	70	66
2005	52	66	93	98	69	55
2006	48	70	90	98	74	53
2007	54	86	94	99	83	42
2008	50	87	95	98	85	41
2009	57	90	96	99	86	48
2010	89	100*	99	100*	94	100*

* The total number of sows in this year did not reach 1000.

3. táblázat Az AFI, NBA és FI tulajdonságok tenyésztékeinek stabilitását jellemző közös egyedek aránya a legjobb 1000 kocából a különböző években (%)

Ebben az évben a kocák száma 1000 alatt volt (*)

This difference can be presented by calculating the difference between the average crossbred breeding values of the pigs ranked once on the purebred and then on the crossbred breeding values (Table 4). The values reflect and confirm the results in addition to Table 3. The highest and most important differences showed AFI for each genotypes (0.9-7.0), while those for FI were negligible. In the trait NBA no differences were found.

Table 4.

Differences between the average crossbred breeding values of the top 1000 sows in maternal breeds

	AFI (days)		NBA (piglets)		FI (days)	
	HLW	HL	HLW	HL	HLW	HL
2001	3.6	0.9	0	0	0.2	0.6
2002	6.3	2.4	0	0	0.3	0.7
2003	6.0	3.0	0	0	0.5	1.0
2004	5.9	3.4	0	0	0.5	0.8
2005	6.0	4.7	0	0	0.4	1.3
2006	7.0	4.3	0	0	0.3	1.3
2007	5.9	2.1	0	0	0.2	1.3
2008	6.1	1.9	0	0	0.2	1.4
2009	4.6	1.5	0	0	0.1	1.4
2010	1.2	0*	0	0*	0.1	0*

* The total number of sows in this year did not reach 1000.

4. táblázat A legjobb 1000 koca átlagos keresztezett tenyésztékei közti különbség az anyai fajtákban

Ebben az évben a kocák száma 1000 alatt volt (*)

CONCLUSIONS

Based on the trends reproductive traits seem hard to improve. The low-medium stability of breeding value of age at first insemination and farrowing interval justify the use of a bivariate model and suggest the application of crossbred breeding values in selection of purebred parents for crossing. For number of born alive piglets however it is enough to take the purebred breeding values into account but according to Wei and van der Werf (1994) the use of crossbred information always leads to extra response in the breeding goal.

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