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LENGTH OF PRODUCTIVE LIFE AND LIFETIME REPRODUCTION EFFICIENCY IN SOWS WITH DIFFERENT ORIGIN*

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Abstract

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The study comprised 1684 sows originated from 131 sires with the following origin: Danube White, Large White with a polish origin, East Balkan swine and fattening pigs, classified in four different farms. Animals were housed in individual pens during period of farrowing and suckling period and for East Balkan swine – free farrowing. Animals were raised in groups during gestation period.

The length of economic use was measured in days from first farrowing to sow culling. In the standard methods of measuring the length of productive life along with the productive days non-productive days were also included (the farrowing interval) which varied in high limits. Variance analysis, estimation of inheritance as well as the genetic correlations was made according the methodology of the mixed linear-statistical models.

The phenotypic variety of the length of productive life in sows was significantly affected by the sources of variation: origin, litter, year of farrowing ($P \leq 0.001$) and season of farrowing ($P \leq 0.01$). Low values of heritability for the studied traits were established. There were mean to high values of the genetic correlations between the studied traits ($r_g = 0.519$, $r_g = 0.587$).

Key words: genetic determination, length of productive life, service period, farrowing interval

Introduction

The long use of farm animals is related with maintaining optimal health status and providing them some comfort during the completely productive life. The quick change of the generations results from the carried out intensive selection of the main productive traits and affects the reducing of the long agricultural use (Engblom et al., 2008; Knaus, 2009). In reference with the above-mentioned fact, it is important for the breeding farms, which carry out an intensive selection to cull sows mainly for health reasons or with reproductive problems while the rest of the population is selected by the main reproductive and productive traits.

The estimation of the level of genetic variation of length of productive life (LPL) and of the part of additive variability, respectively, depends on the population size, on the definition of the measured traits i.e. for how much time it is registered and depends on the used statistical models. The analyses of the length of life – survival analyses include censored database as well as separating the non-productive days, equalizing the number of the born alive from first litter to the rest of the litters and so on. The increase of the percent of the censored data decreases the values of inheritance. It should be pointed out that the values characterizing the level of heritability of the trait LPL are higher for the survival analyses from 0.11 to 0.33 (Yazdi et al., 2000a, b; Serenius and Stalder, 2004), while using the lineal models the heritability is between 0,02 and 0,11 (Tholen et al., 1996a,b; Lo'pez-Serrano et al., 2000). Other methodological tests which compare survival analyses, analyses with forming a group of data and linear models confirm the above explained tendency (Serenius and Stalder, 2004; Mészáros et al., 2010).

The aim of the present study was to establish the sources of specific variance and genetic determination for the traits length of productive life, service period and farrowing interval in sows with different origin.

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Material and Methods

The study comprised 1684 sows originated from 131 sires with the following origin: Danube White, Large White with a polish origin, East Balkan swine and fattening pigs, classified in four different farms. The investigated origins are with reduced productive traits because of the traditional way of breeding relevant to lower health status and insufficient balanced ration as well as of the seasonal farrowing cyclic recurrence (Large White and East Balkan swine).

Animals were housed in individual pens during period of farrowing and suckling period and for East Balkan swine – free farrowing. Animals were raised in groups during gestation period. Animals were fed with compound feed for the corresponding category.

The study was carried out during the period 1999 - 2009. The litters were fixed from first to ninth as the next ones were excluded from the analysis because of their small number. The farrowing seasons were classified: winter from December to February, spring from March to May, summer from June to August and autumn from September to November.

The length of economic use was measured in days from first farrowing to sow culling. Using the standard methods of measuring the length of productive life along with the productive days non-productive days were also included (the interval from farrowing of the litter to insemination) which varied in high limits.

The length of lactation and the weaning period of the litter differ for the separate origins which caused a registration of the period from farrowing to insemination (service period) as a trait with productive as well as non-productive period in it.

The traits length of economic use of sows from first to final farrowing, service period and farrowing interval were an objective of the analysis. The number of born alive piglets was included in the model as a regressor.

Variance analysis, estimation of inheritance as well as the genetic correlations was made according the methodology of the mixed linear-statistical models (Harvey, 1990).

The data analysis was based on the following statistical model:

$$Y_{i\text{-}p} = \mu + S_I + B_{J(1\text{-}3)} + L_{K(1\text{-}10)} + Y_{L(1\text{-}10)} + SE_{M(1\text{-}4)} + R_{NBA} + e_{i\text{-}o},$$

where:

μ - mean;

S_I - random effect of the sire (1-131);

$B_{J(1\text{-}3)}$ - fixed effect of the breed (1-3);

$L_{K(1\text{-}10)}$ - fixed effect of the litter (1-9);

$Y_{L(1\text{-}10)}$ - fixed effect of the year (1-11);

$SE_{M(1\text{-}4)}$ - fixed effect of the farrowing season (1-4);

R_{NBA} - regressive effect of number of born alive;

$e_{i\text{-}o}$ - residual variance.

The normal data classification of the traits was an objective of an analysis. It was done by using the logarithmic transformation of the measured values.

The differences between the levels of studied factors were established regarding the degree of distribution according to Studant (Hayter, 1984):

$$(y_i - y_j) / \ S \sqrt{(1/n_i + 1/n_j)} /2,$$

where: $(y_i - y_j)$ – differences between the mean values of the levels from the studied factor ; S – square deviation; n_i and n_j – number of the individuals for the corresponding levels.

Results

The mean values and the variation of the studied traits are presented in Table 1. The standard square deviation is in high levels. Mészáros et al. (2010) establish similar results, where the square deviation of LPL is close and higher than our studies have determined. The level of variation to 0,106 – 2.37% for the studied traits is reduced by using logarithmic transformation of the measured values which causes some decrease of the statistical error of the estimation through the achievement of normal distribution for the analyzed data. With respect to the regression coefficient, some significance of the results after transforming the information ($P \leq 0.001$) is established between the studied traits and the number of born alive.

Variance analysis and the F – test are presented in Table 2. The results show high significant influence of the studied factors for the trait length of economic use ($P \leq 0.001$) as well as the season, which also shows significant influence ($P \leq 0.01$). The farrowing interval is significantly influenced by the origin ($P \leq 0.05$) and the year of birth ($P \leq 0.01$), and the period

Table 1
Estimation of service period and sow longevity based on real and transformed phenotypic values

Traits	Length of productive life (LPL)		Service period (SP)		Farrowing interval (FI)	
	Real	Transform	Real	Transform	Real	Transform
LSM	941.3	2.90	77.76	8.75	191.67	2.268
SD	425.8	0.25	57.58	2.37	58.10	0.106
$C_{(A)}$	29.9	6.01	68.30	11.24	2.62	1.850

from farrowing to insemination is influenced by the season (P≤0.01) and the origin (P≤0.001).

The coefficient values of determination for the traits farrowing interval and LPL (R = 0.993 and R = 0.570) give us some reason to suppose that the included in the model factors describe significantly the variation of the same traits. With respect to the service period, the low indexes of the coefficient of determination are caused by the big differences in the length of feeding period and there are differences caused by the seasonal character of the inseminations.

The constants characterizing the length of productive life indicated that with highest length of economic use were East Balkan swine (1315.8 days) and Large White with a polish origin (1098.6 days) (Table 3). Differences between the separate origins were with high significance (P≤0.001) except for the ones between the sows from Danube White and fattening pigs (38 days). The length of economic use was higher during the first six years from the studied period and the differences between the separate years were significant (P≤0.001). During the period 2005-2008 were established lower values of LPL and differences between the years were smaller (Figure 1). There was a tendency of decreasing the length of economic use. The season as a factor significantly influenced on LPL (P≤0.01) but the differences between the different seasons were low and in the given study, some significance between the summer and the autumn season only was established (P≤0.05).

The effect of the serial litter is also presented in the same table and indicates that with an increase of the consecution of farrowing, the number of days for the studied traits increases too. The differences between the separate litters for the same trait are significant and high significant (P≤0.01, P≤0.001) except for those between the last three litters because of the smaller number of sows in them. The number of the culled sows is influenced by the order of litter and after sixth and seventh litter, their number significantly decreases (Figure 2). The percent of the culled sows from Large White with a polish origin is the lowest. There are also similar results for the hybrid swine's to third litter and after that the percent of the culled sows increases in high level.

The period from farrowing to insemination, (service period) is the longest for East Balkan swine as the differences

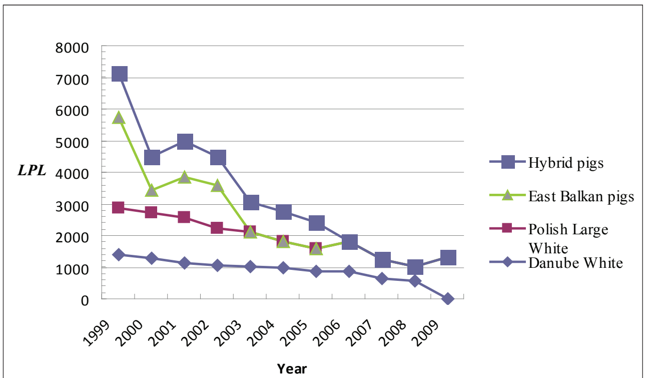

Fig. 1. Influence of the year on the length of productive life

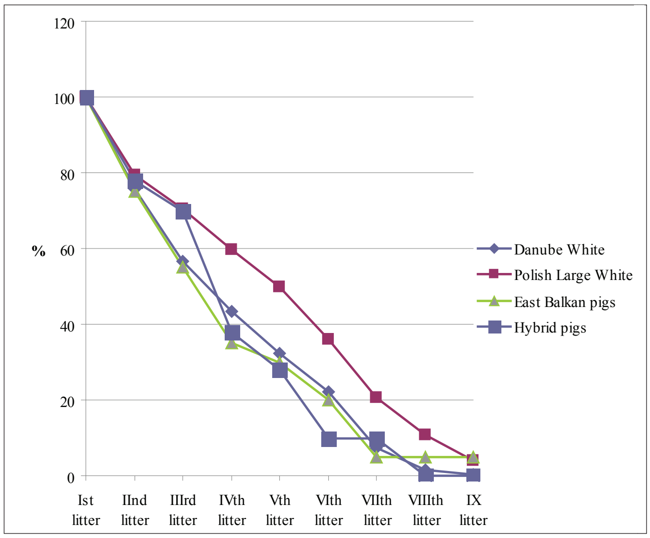

Fig. 2. Percentage of culled sows

Table 2
ANOVA of the examined traits

Sources of variability	df	Length of productive life	Farrowing interval	Service period
		F-test	F-test	
Breed	3	+++	+	+++
Year of birth	10	+++	++	
Season of farrowing	3	++	n.a.	++
PPL	8	+++		
Coeff. of determination-R^2 of the model	Real values	0.570	0.993	0.143

Level of significance: $^{+}$ P ≤0.05, $^{++}$ P ≤0.01, $^{+++}$ P ≤0.001, n. a. - not available with the other origins are high significant (P≤0.001) (Table 4). The received values for East Balkan swine are result from the stud character of breeding, the long period of suckling and the seasonal cyclic recurrence of insemination. The differences between the separate years for the same trait are with different level of significance. Higher values of the service period are established during the first three years while in the next years its duration becomes smaller. The duration of the service period is influenced by the season as it was expected and the differences between the winter – spring and spring – summer season are significant (P≤0.05) which is related with the higher insemination during the cold periods. Close values

Table 3
Effects of the breeds, the litters, the years and the seasons upon the length of productive life

Length of productive life					
Factors	Levels	Number	LSC real	Significance between levels of the factors	LSC±SE Transform
LSM		1684	1079.0±29.7		2.92±0.02
Origin	Danube White	936	932.4±29.9	1 – 3***, 4***	2.87±0.02
	crossbreeds	156	970.5±37.6	2 – 3***, 4***	2.90±0.02
	Large White	526	1098.6±30.5	3 – 4***	2.94±0.02
	East Balkan	66	1315.8±55.5		2.98±0.04
Year	1 1999	66	1586.8±48.6	1 – 2,3,4,5,6,7,8,9,10***	3.19±0.03
	2 2000	206	1374.3±32.9	1 – 11*	3.11±0.02
	3 2001	301	1269.2±28.1	2 – 3,4,5,6,7,8,9,10***	3.07±0.01
	4 2002	310	1114.4±29.0	3 – 4,5,6,7,8,9,10***	2.97±0.02
	5 2003	414	1105.6±29.1	4 – 6,7,8,9,10***	2.98±0.02
	6 2004	195	1001.4±33.7	5 – 6,7,8,9,10***	2.93±0.02
	7 2005	130	907.5±38.6	6 – 7,10,11**	2.85±0.02
	8 2006	32	894.9±61.5	6 – 9***	2.84±0.04
	9 2007	19	730.7±75.2	7 – 9,10*	2.65±0.05
	10 2008	4	577.3±153.9	7 – 11***	2.47±0.09
	11 2009	7	1310.5±144.0	8 – 11**	3.11±0.09
				9 – 11***	
				10 – 11**	
Seasons	1 Winter	277	1094.9±33.5		2.93±0.02
	2 Spring	547	1077.0±31.3	3 – 4*	2.92±0.02
	3 Summer	293	1049.2±33.9		2.89±0.02
	4 Autumn	567	1095.8±31.1		2.94±0.02
Litter	Ist litter	468	741.6±27.5	1 – 2,3,4,5,6,7,8,9,***	2.71±0.02
	IInd litter	350	869.7±29.2	2 – 3**	2.84±0.02
	IIIrd litter	288	931.7±30.1	2 – 4,5,6,7,8,9***	2.88±0.02
	IVth litter	219	1015.9±31.7	3 – 4**	2.93±0.02
	Vth litter	170	1073.7±33.2	3 – 5,6,7,8,9***	2.95±0.02
	VIth litter	113	1135.0±36.9	4 – 6,7,8***	2.97±0.02
	VII litter	51	1228.4±47.4	4 – 9**	2.99±0.03
	VIII litter	18	1361.8±72.5	5 – 7**	3.03±0.05
	IX litter	7	1356.2±112.0	5 – 8***	3.00±0.07
				5 – 9*	
				6 – 8**	
Regression $R_{lpl/nba}$			1.04±3.1		0.0005***±0.019
Regression $R_{lpl/fi}$			0.51±0.13***		0.00043***± 0.0008

Level of significance: *P ≤0.05, ** P ≤0.01, ***P ≤0.001

are established regarding the trait farrowing interval as the differences are small and insignificant (190-192 days).

The additive variability for the studied traits is in low limits as the heritability for the trait length of productive life (h^2 = 0.13) is the highest, the farrowing intervals and intervals to next farrowing are close to zero (Table 5). The phenotypic dependences between the studied traits are low (r_p = 0.097 и r_p = 0.138) while the values of the genetic correlations are mean

Table 4
Effects of the breeds, the litters, the years and the seasons upon the service period

Service period						
Factors	Levels		Number	LSC real	Significance between levels of the factors	LSC±SE Transform
LSM			1684	94.5±4.82		1.87±0.02
Origin	Danube White		936	71.5±4.79	1 – 4***	1.79±0.01
	crossbreeds		156	75.8±6.38	2 – 4***	1.81±0.02
	Large White		526	72.7±5.10	3 – 4***	1.83±0.02
	East Balkan		66	158.1±9.97		2.08±0.04
Year	1	1999	66	108.9±8.89	1 – 4*	1.94±0.04
	2	2000	206	103.6±5.68	1 – 5,6***	1.91±0.02
	3	2001	301	100.6±4.56	2 – 4*	1.90±0.02
	4	2002	310	95.8±4.69	2 – 5,6***	1.87±0.02
	5	2003	414	87.9±4.72	3 – 5,6***	1.84±0.02
	6	2004	195	85.9±5.63	4 – 5*	1.85±0.02
	7	2005	130	97.4±6.61	4 – 6**	1.88±0.03
	8	2006	32	97.3±11.20	5 – 7*	1.90±0.04
	9	2007	19	94.5±13.70	6 – 7*	1.88±0.06
	10	2008	4	82.2±28.20		1.84±0.12
	11	2009	7	85.8±27.10		1.84±0.11
Seasons	1	Winter	277	91.5±5.65	1 – 2*	1.86±0.02
	2	Spring	547	98.0±5.14	2 – 3*	1.91±0.02
	3	Summer	293	91.5±5.73		1.85±0.02
	4	Autumn	567	97.1±5.14		1.89±0.02
Litter	Ist litter		468	103,0±5.12	1 – 2**	1.91±0.02
	IInd litter		350	93.5±5.47	1 – 3,4,5,6***	1.87±0.02
	IIIrd litter		288	56.9±5.65	1 – 9*	1.84±0.02
	IVth litter		219	89.2±5.94	2 –3,5*	1.85±0.02
	Vth litter		170	85.6±6.23	2 – 6**	1.84±0.02
	VIth litter		113	82.0±6.94		1.83±0.03
	VII litter		51	91.3±8.90		1.88±0.03
	VIII litter		18	94.8±13.60		1.88±0.05
	IX litter		7	66.9±21.00		1.78±0.08
$R_{ser/ng}$				0.003***±0.57		
$R_{ser/kal}$						

Level of significance: *P ≤0.05, **P ≤0.01, ***P ≤0.001

Table 5
Heritability, phenotypic and genetic correlations of the studied traits

Traits	Length of productive life		Heritability
	r_p	r_g	h^2
Farrowing interval	0.138	0.587	0.036
Service period	0.097	0.519	0.062
LPL			0.130

to high (r_g = 0.519-0.587) which supposes an effectively of the indirect selection between them.

Discussion

The reasons for culling the sows are mainly their productivity and health status, which may vary depending on the year or the conditions of breeding, i.e. ones and the same by size litters of sows, may be treated through different way in the different farms and during the different years. In our studies, we have established some results, which are in line with the studies of other authors and indicate relation between the number of the culled sows and the order of litter. Engblom et al. (2008) found out that the risk of culling the sows between II and IV litter was not too big and after that, the grew bigger. According to Brant et al. (1999) some decision for culling the sows was taken rarely when they were on IV- V litter.

There were a lot of studies for analyzing the length of productive life, for example for Large White and Landrace breeds the length of economic use was 503 and 576 days (Tarres et al., 2006; Yazdy et al., 2000b), while Meszaros et al. (2010) have established 617 and 602 days. The same authors have noticed that this trait was influenced by the long treated period, the censored extract, the equlizing the results from the first litter with the next ones etc. The values established in our studies for LPL were higher than the described ones in the literature because the animals were raised in an extensive way with different period of breeding and insemination as well as the fact that the tested animals were purebred and fattening pigs. Because of the above-mentioned reason, some authors recommended the productive life to be measured by the number of finished farrowings (litters) (Mészáros et al., 2010).

Conclusion

The phenotypic variety of the length of productive life in sows was significantly affected by the sources of variation: origin, litter, year of farrowing ($P \leq 0.001$) and season of farrowing ($P \leq 0.01$). Low values of heritability are established for the studied traits. The values of the genetic correlations are mean to high (r_g = 0.519-0,587) between the studied traits.

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