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Genetic and Phenotypic Parameters for Reproduction Traits of Landrace Sows in Latvia

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Summary

The aim of this study was to investigate reproduction performance in the 1st and 2nd parity of Latvian Landrace sows, to estimate genetic parameters for reproduction traits, and to determine their genetic correlations with age at the first farrowing (AFF) and weaning to insemination interval (WII) in the Latvian Landrace swine population. Data from 2054 of the 1^{st} parity and 1416 of the 2^{nd} parity sows were collected from 2005 till 2010 and were included in the analysis. Four reproduction traits in the study were analysed: number of piglets born alive (NBA), number of piglets dead (ND), number of piglets weaned per litter (NW) and 21-day litter weight (W21). Genetic parameters were estimated with multi traits animal model using REML procedure. The heritability estimates in the first parity were 0.07, 0.16, 0.36, 0.01 and 0.32 for NBA, NW, W21, AFF and WII, respectively. Between AFF and sows reproduction traits in the first and the second parity unfavourable genetic correlations were found in the present data set. Moderate negative genetic correlation between WII and sows reproduction traits was observed.

Key words

pig, reproduction, genetic parameters

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Introduction

The number of born alive and weaned piglets as well as short of the weaning to insemination interval maximise profitability of the breeding herds. Two maternal breeds Landrace and Yorkshire are used in pig breeding programme in Latvia. The breeding goals in the swine selection program in Latvia for the maternal breed are to increase the number of piglets weaned per sows per year, with emphasis on increase of the parity per sows per year and decrease of the weaning to service interval till 11 days.

The genetic gain in the population depends on selection intensity, heritability, genetic correlations between traits and diversity in the population. Reduction of the generation interval is a highly efficient measure to increase the genetic gain per year.

Heritability is estimated for the most important female reproductive traits such as: number of born alive, litter birth weight, number of weaned and farrowing interval. Estimated posterior means of heritability of reproduction traits in the Finnish Landrace swine population were 0.16, 0.09, and 0.08 for the age at first farrowing, number of piglets weaned at the first farrowing, and the first wean-to-insemination interval, respectively (Serenius et al., 2008). In the Dutch Landrace sows population heritability was found to be low for farrowing after the first insemination and number of the still born piglets; moderate for a number of piglets born in total or alive and interval from weaning to the first insemination; and high for the age of the first insemination. Heritability increased slightly with parity number for a number of piglets born in total and alive, increased markedly for a number of still born piglets, and decreased for interval from weaning to the first insemination (Hanenberg et al., 2001). Imboonta et al. (2007) reviewed parameter estimates for reproduction traits, and concluded that the heritability of a number of piglets born alive, number of stillborn piglets, and a number of piglets born alive but dead within 24 h was around 0.05 in the first and later parity. Heritability is usually estimated for pigs reproduction traits around 0.10 or even less, response to selection also would be expected to be low (Rothschild, 1996).

Aim

The objective of this study was to estimate genetic parameters for reproduction traits, and determine its genetic correlation with age at first farrowing (AFF), age at second farrowing (ASF) and weaning to insemination interval (WII) in Latvian Landrace sows population.

Material and methods

Data used in this study were obtained from Pig Breeding Centre in Latvia. Analysed data included reproductive performance records about 2054 1st parity and 1416 2nd parity Landrace breed pigs during the period from 2004 to 2010.

Sow`s identity, parents identification number of each sow, sow's birth date, first mating and farrowing date, number of piglets born alive (NBA), number of dead (ND), average weight of piglets in 21 day (W21), number weaned per litter (NW) and weaning date were recorded for each pig. AFF and ASF were defined as the interval from the birth of the sow to her first and second farrowing; and WII was defined as the interval from the first weaning to successful insemination. Distribution of the data over the year of test, month and age at first and second farrowing are shown in Table 1.

Table 1. Distribution of test records in analysed data material

Test year	n	Month	n	AFF[1] (month)	n	ASF[2] (month)	n
2005	583	1	269	≤10	32	≤15	60
2006	825	2	234	11	908	16	444
2007	548	3	289	12	765	17	439
2008	589	4	347	13	297	18	287
2009	862	5	346	14	124	19	151
2010	63	6	250	15	47	20	61
		7	319	16	10	21	25
		8	306	17	7	22	10
		9	321	≥18	1	≥23	5
		10	286				
		11	241				
		12	262				

[1] AFF - age at the first farrowing (month); [2] ASF - age at the second farrowing (month).

The multi-traits animal model for the heritability and genetic correlations evaluation were used:

$Y_{ijkl} = \mu + A_i + YS_j + AFF_k + e_{ijkl}$,

Y_{ijkl} = ijkth observation of reproductive traits;

μ – population mean;

A_i – animal random effect;

YSj – fixed effect of j-th year-season class;

AFF_k – age at first farrowing as covariate effect (with an exception for AFF);

e_{ijk} – residual effects.

Data in tables are represented as mean ± standard error. The investigation data was processed using SPSS program. Genetic parameters (heritability and genetic correlations) of reproduction traits were estimated by REML method using WOMBAT software (Mayer, 2010) applying multi-trait animal model.

Results and discussion

Least square means, standard errors and range of sows' reproduction traits are presented in Table1. The average number of NBA in the first parity was 9.1 and in the second 10.3 piglets per litter. 92% of the sow's had 6 - 19 piglets and only 8% up to five piglets per litter. Low mortality at the first and second parity – 1.3 and 1.1 piglets also is good indicator. Number of NBA and NW increases with parity ($p<0.05$; $p<0.001$), but number of ND does not differ with parity.

The results show that the average AFF was 360.6 days to first parity and 524.9 to second parity. The mean WII, which represents the period from weaning to insemination, was accordingly 19.4 and 16.4 days. The variation of WII was considered to be mostly influenced by environmental factors and large standard deviation indicates the variability of those measures. Only 49% of the sow's had WII till 11 days that is in accordance with pig selection program in Latvia and 51% of sows had WII till 100 days. If estrous symptoms after weaning were weak, the first estrous may pass undetected and farrowing interval would immediately become three weeks longer.

Table 2. Least square means of litter traits for the 1st and 2nd parity

Traits	1st parity (n=2054)		2nd parity (n=1416)		p-value
	$\bar{x} \pm S_{\bar{x}}$	Min to max	$\bar{x} \pm S_{\bar{x}}$	Min to max	
[1]NBA (piglets)	9.1±0.48	1 to 19	10.3±0.39	1 to 19	0.041*
[2]ND (piglets)	1.3±0.22	0 to 15	1.1±0.18	0 to 13	0.259NS
[3]NW (piglets)	9.1±0.20	0 to 15	10.0±0.16	4 to 13	<0.001
[4]W21 (kg)	57.1±1.28	22 to 91	64.5±1.05	28 to 91	<0.001
[5]AFF (days)	360.6±0.85	299 to 594	524.9±0.98	443 to 732	<0.001
[6]WII - (days)	19.4±0.41	4 to 100	16.4±0.48	4 to 98	<0.001
[7]LD (days)	27.3±0.05	17 to 35	27.1±0.06	18 to 34	0.08NS

[1]NBA – number of born alive per litter; [2]ND - number of dead per litter; [3]NW – number of weaned per litter; [4]W21 – 21-day litter weight; [5]AFF - age at the first farrowing; [6]WII - weaning to insemination interval; [7]LD – lactation period; *= P<0.05; **= P<0.01; ***= P<0.001; NS=not significant.

Table 3. Heritability (h^2), additive genetic (σ_a^2) and residual (σ_e^2) variance of performance traits in the first parity

Traits	Variance		$h^2 \pm S_{h^2}$
	σ_a^2	σ_e^2	
[1]NBA (piglets)	0.709 ± 0.282	9.101 ± 0.374	0.07 ± 0.028
[2]ND (piglets)	0.205 ± 0.080	2.126 ± 0.087	0.09 ± 0.034
[3]NW (piglets)	0.313 ± 0.082	1.629 ± 0.071	0.16 ± 0.040
[4]W21 (kg)	25.834 ± 5.481	46.868±3.515	0.36 ± 0.062
[5]AFF (days)	6.779 ± 45.490	670.307±76.138	0.010 ± 0.067
[6]WII - (days)	125.029 ± 27.146	272.308±19.033	0.32 ± 0.060

[1]NBA - number of born alive per litter; [2]ND - number of dead per litter; [3]NW – number of weaned per litter; [4]W21 – 21-day litter weight; [5]AFF - age at the first farrowing; [6]WII - weaning to insemination interval.

σ_a^2 σ_e^2

Table 4. Heritability (h^2), additive genetic (σ_a^2) and residual (σ_e^2) variance of performance traits in the second parity

Traits	Variance		$h^2 \pm S_{h^2}$
	σ_a^2	σ_e^2	
[1]NBA (piglets)	0.712 ± 1.474	9.466 ± 0.001	0.07 ± 0.135
[2]ND (piglets)	0.181 ± 0.001	1.922 ± 0.356	0.08 ± 0.015
[3]NW (piglets)	0.699 ± 0.502	1.073 ± 0.001	0.39 ± 0.171
[4]W21 (kg)	11.379 ± 19.391	55.315 ±0.001	0.17 ± 0.241
[5]WII - (days)	55.783 ± 45.298	186.726±0.001	0.23 ± 0.144

[1]NBA – number of born alive per litter; [2]ND - number of dead per litter; [3]NW – number of weaned per litter; [4]W21 – 21-day litter weight; [5]WII - weaning to insemination interval.

Heritability, additive genetic and error variances for the first and the second parity are summarised in Table 3 and Table 4. In different studies heritability of NBA, ND and NW traits were around 0.1 (Hanenberg et al., 2001; Radojkovič et al., 2005; Serenius et al., 2008). Heritability of zero or close to it indicates that all differences between animals are due to environmental causes.

The estimated heritability of NBA, ND and NW per litter piglets in the first parity in the given study was low (h^2 =0.07 - 0.16), but the smallest heritability was to AFF (h^2 = 0.07). The highest direct heritability was estimated for W21 (h^2 = 0.36), followed by WII (h^2 = 0.32).

Lundgren et al. (2010) concluded heritability estimates for weaning to service interval were 0.08 and 0.03 in the Landrace sows population as well as in Chansomboon et al. (2009) investigation in Landrace and Large white population weaning to the first service interval heritability estimated was low (0.024). All of heritability estimates to reproduction traits in the second parity are considered to be low. It means that the response to selection also would be expected to be low.

The estimated correlations of the analyzed traits are provided in Table 4. Age at farrowing has been genetically unfavourably associated with piglets weaned at the first farrowing (r_g=0.08) in Serenius et al. (2008) reported study.

Estimates of genetic correlations between the traits examined in the current study ranged from -0.08 to 0.24 and had high standard errors. Genetic correlation between the age at parity and the reproduction traits are very small in the first parity and increase in the second parity (Table 5).

The highest correlations are between the age at the second parity and NW per litter and W21 - 0.18 ± 0.118 and 0.24 ± 0.198, respectively. The number of weaned piglets and litter weight had tendency to increase with sows' age at the second parity. This indicates that decreasing AFF through selection will not have such an effect on reproduction traits. Biological explanation could be that the sow then would be older and closer to her adult weight, consequently using fewer resources for growth (Holm et al., 2005). Estimated phenotypic correlations between WII and reproduction traits were very low (Table 6).

Significant negative genetic correlations were between sows WII and 2nd parity sows reproductive traits: NBA (r_g = -0.40),

Table 5. Estimates of genetic and phenotypic correlations of age at the first and the second parity and sows reproductive traits

Traits	Age at first parity		Age at second parity	
	$r_g \pm S_r$	$r_p \pm S_r$	$r_g \pm S_r$	$r_p \pm S_r$
[1]NBA (piglets)	0.13 ± 0.193	0.003 ± 0.039	0.16 ± 0.178	0.03 ± 0.028
[2]ND (piglets)	-0.04 ± 0.213	-0.01 ± 0.034	-0.08 ± 0.155	0.02 ± 0.030
[3]NW (piglets)	-0.05 ± 0.167	-0.01 ± 0.032	0.18 ± 0.118	0.05 ± 0.031
[4]W21 (kg)	-0.03 ± 0.031	-0.01 ± 0.026	0.24 ± 0.198	0.02 ± 0.027

[1]NBA – number of born alive per litter; [2]ND - number of dead per litter; [3]NW – number of weaned per litter; [4]W21 – 21-day litter weight.

Table 6. Estimates of genetic and phenotypic correlations of weaning insemination interval and 2nd parity sows reproductive traits

Traits	$r_g \pm S_r$	$r_p \pm S_r$
[1]NBA (piglets)	-0.40 ± 0.207	-0.02 ± 0.031
[2]ND (piglets)	0.09 ± 0.176	0.01 ± 0.034
[3]NW (piglets)	-0.68 ± 0.140	0.04 ± 0.037
[4]W21 (kg)	-0.60 ± 0.260	0.06 ± 0.032

[1]NBA - number of born alive per litter; [2]NS - number of dead per litter; [3]NW - number of weaned per litter; [4]W21 – 21-day litter weight.

NW (r_g = -0.68), and W21 (r_g = -0.60). Sows inseminated in the 3rd and the 4th estrous, with weaning service period more than 50-60 days have a small number of born and weaned piglets. Moderate negative genetic correlation r_g =-0.34 between number of piglets weaned at the first farrowing and the first wean-to-insemination interval were also observed in Serenius et al. (2008) study. Lundgren et al. (2010) concluded the ability to raise fast growing, heavy piglets seems to have an unfavourable effect on total number born in the next litter but not on the weaning to service interval.

Conclusions

Analysis of this study showed that sows reproduction traits NBA and NW increase with parity number. Heritability coefficients for NBA and NW in the first and the second parity were in the interval from 0.07 and 0.16 – 0.39, respectively. The phenotypic variation in AFF and WII is large with heritability coefficient 0.01 and 0.32. Sows with optimal AFF and small WII improve the efficiency of the sow per time unit. Reproduction traits of the second parity sows were higher for sows with small WII. There was non-significant tendency for sows with small AFF to have lower reproduction traits. It is concluded that selection of breeding stock for decrease of AFF and WII to increase the efficiency of the sow per time unit.

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