Estimates of genetic parameters for competition effect in selected line of Duroc pigs

Email: toikawa@cc.okayama-u.ac.jp

T. Oikawa[1], A. Nagata[1], M. Tomiyama[1], K. Suzuki[2], H. Kadowaki[3] and T. Shibata[3]*

[1]Faculty of Agriculture, Okayama University, [2]Faculty of Agriculture, Tohoku University,

[3]Miyagi Prefecture Animal Industry Experiment Station, Japan

Introduction

Animal's growth is influenced by direct genetic effect, environmental effects and, in addition, association of other animals (Figure 1). In animal breeding, it is well-known that maternal effect has important effect on animal's early performance. With similar concept to the maternal effect, a model with both direct genetic effect of an animal and a genetic competition effect of its pen-mates was proposed in the last WCGALP, where possibility of genetic evaluation for the competition effect was suggested. Objective of this study was to reveal relative importance of competition effect in regular breeding programme to investigate necessity and possibility of genetic evaluation for competition effect in Duroc pigs.

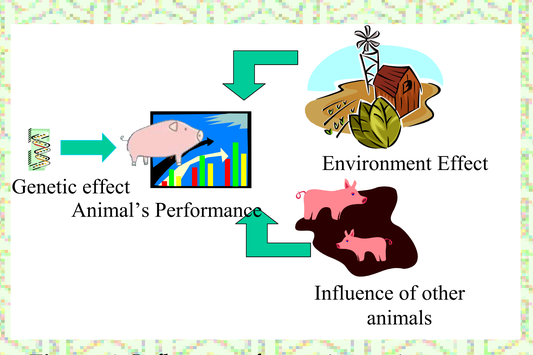

Figure 1. Influence of genetic, environment effect and associated other animals on animal's performance.

Table 1. Data structure of Duroc records

Variables	Class	Number
Animals		1262
	Female	717
	Slaughtered	545 (151)*1
Generation	1	152 (60)*2
	2	208 (89)
	3	189 (83)
	4	190 (84)
	5	166 (75)
	6	172 (73)
	7	185 (81)

*1Female numbers are in parentheses.
*2Numbers of slaughtered animals are in parentheses.

Animals

Growth and carcase performance were recorded on Duroc pigs during seven generations of selection programme (Table 1). They were selected for daily gain (DG), backfat thickness (BFT), eye muscle area (EMA), intramuscular fat content (IMF) with two-stage selection programme (Figure 2). Traits studied in this analysis were gain on test (ADG), age at 105kg body weight (AGF), ultrasound backfat thickness (UBF) and scanned loin muscle area (LMA). Pen-mate animals were composed of two litters. A litter was divided into two groups after weaning, and two different litters were grouped and raised together within a pen (9.6m²). All animals were fed *ad libitum*. Concept of the competition model is illustrated in Figure 3.

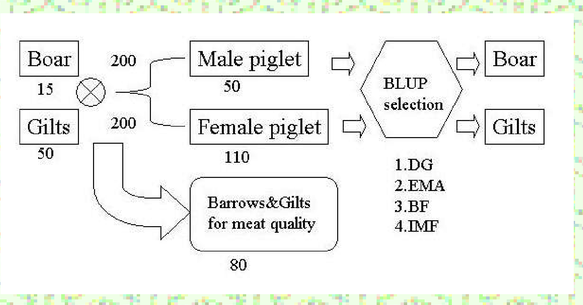

Figure 2. Design of selection programme for Duroc pigs.

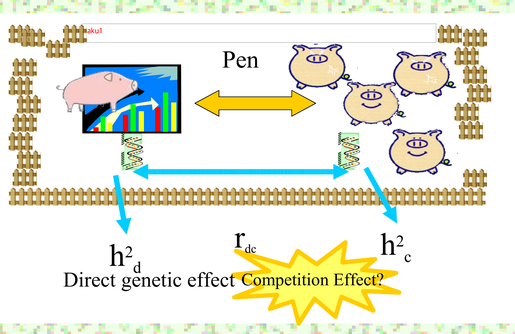

Figure 3. Relationship between animal's direct genetic effect and competition effect.

Statistical analysis

A statistical model included fixed effect, pen group effect (*pg*), direct genetic effect (*d*) of an animal genetic competition effect (*c*) of the other animals. Covariance components for the traits were estimated by REML using maximizing engine of remlf90. Covariance structure of the effects is shown below.

$$Var\begin{bmatrix} d \\ c \\ pg \\ e \end{bmatrix} = \begin{bmatrix} A\sigma^2_d & A\sigma_{dc} & 0 & 0 \\ A\sigma_{dc} & A\sigma^2_c & 0 & 0 \\ 0 & 0 & I\sigma^2_{pg} & 0 \\ 0 & 0 & 0 & I\sigma^2_e \end{bmatrix}$$

Table 2. Means with SD for traits studied

	ADG (g)	AGF (days)	UBF (cm)	LMA (cm^2)
Mean	661.7	162.2	2.45	3.72
SD	53.0	12.7	0.42	0.42
CV	0.08	0.08	0.17	0.11

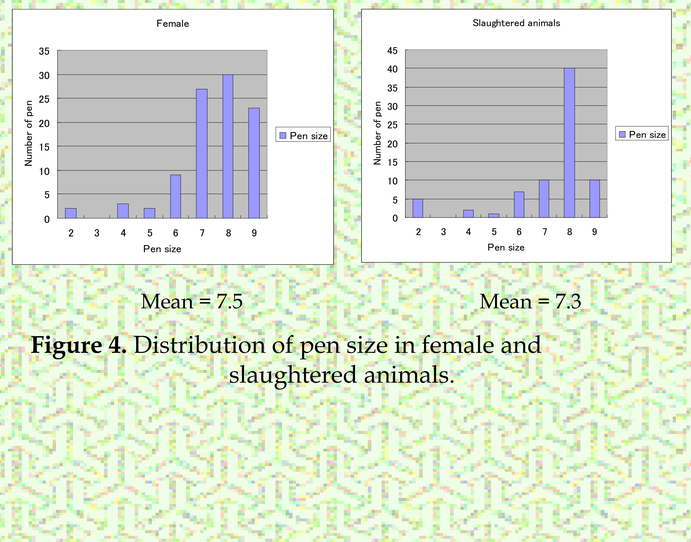

Figure 4. Distribution of pen size in female and slaughtered animals.

Results

Means and SD of the traits were presented in Table 2. UBF has larger CV than the other traits. Distribution of pen size was presented in Figure 4. The distribution of pen size is scattered from 7 to 9 in female animals, whereas it is centered at pen size of 8 in slaughtered animals.

Table 3. Heritability of genetic direct effect (h^2_d)and competition effect (h^2_c), genetic correlation(r_{dc}) between them and proportion of pen variance (p^2) in ADG

	Female						Slaughtered					
Model	-2logL	σ^2_p	h^2_d	h^2_c	r_{dc}	p^2	-2logL	σ^2_p	h^2_d	h^2_c	r_{dc}	p^2
Base	–	1610	0.55	–	–	FIX	–	2073	0.60	–	–	FIX
SB1	7324	2200	0.39	–	–	0.20	5704	2650	0.52	–	–	0.19
SB2	6008	2099	0.39	0.01	0.0	0.19	4709	2621	0.51	0.01	0.0	0.15
Full	6007	2106	0.37	0.01	−0.25	0.20	4707	2608	0.57	0.01	0.63	0.06

σ^2_p: phenotypic variance, SB1,SB2: two sub-set models.

Table 3 shows estimates of genetic parameters in ADG. The Base model includes only animal's direct genetic effect as a random effect (and random residual). SB1 additionally includes random pen effect. SB2 includes genetic competition effect but r_{dc} was fixed to be 0. The heritabilities of direct effect were moderate to high. The heritabilities of competition effect were around 0.01, although the genetic variance of competition effect is statistically significant. This result is consistent with the low heritability (0.03) in the recent report. The genetic correlations were different between the data set, but they were statistically indifferent from zero.

Table 4. Effect of pen size on estimates of genetic parameters of ADG

Pen size	σ^2_p	h^2_d	h^2_c	r_{dc}	p^2
Total	2300	0.41	0.01	0.02	0.14
Large	1955	0.39	0.01	−0.73	0.18
Small	2175	0.38	0.03	0.35	0.01

σ^2_p: phenotypic variance, P^2: proportion of pen variance on phenotypic variance,
Large and small at pen size are n>8(mean=9.0) and n<8 (mean=6.4), respectively.

Table 4 presents effect of pen size on genetic parameters of ADG. Heritabilities of direct effect were moderate. Heritabilities of the competition effect were very low, however, the heritability in the small pen size was higher than the large pen size, suggesting that data set with small pen size is more appropriate for detection of the competition effect. The proportion of pen effect was lower in the data set of small pen size.

Table 5. Estimates of genetic parameters for AGF and carcase traits

Trait	σ^2_p	h^2_d	h^2_c	r_{dc}	p^2
AGF	130	0.46	0.01	0.50	0.06
UBF	0.15	0.69	0.00	0.25	0.03
LMA	0.15	0.54	0.00	0.31	0.02

σ^2_p: phenotypic variance, P^2: proportion of pen variance on phenotypic variance,
AGF: age at 105 kg BW, UBF: ultrasound back fat thickness, LMA: loin muscle area,

Table 5 presents estimates of genetic parameters for AGF and carcase traits. Heritabilities of UBF and LMA are slightly higher than reported estimates. Heritabilities of competition effect were less than 0.01 for UBF and LMA, indicating negligible effect on carcase traits. Proportions of pen effect were low in UBF and LMA.

Conclusion

For growth and carcase traits, negligible genetic competition effects were estimated, which may indicate good feeding condition of this testing programme. In ADG, larger competition effect was estimated for small pen size, suggesting advantage of small pen size for detection of the competition effect. Further study is necessary to verify this point.