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Genetic relationships between meat productivity and reproductive performance in Berkshire pig

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【Introduction】

Many breeding programs were constructed including growth traits of piglet and reproductive traits of sows because those traits directly influence farmer's income. Genetic relationships between piglet growth and sows reproductive performance were often reported unfavorable.

We have studied performance traits, carcass traits and reproductive traits. The genetic relationships between those traits have, however, not been studied in the Berkshire population.

The objective of this study was to estimate the genetic parameters for meat productivity and reproductive performance in Berkshire pig.

【Materials and Methods】

Berkshire pigs in Okayama were founded on base population introduced from Kagoshima prefecture in 1978. The data used in this study were collected in Japan on 4,773 purebred Berkshire (2,458 males and 2,315 females) pigs at the Okayama Prefectural Animal Husbandry and Research Center. Records of sows in present study were collected on 564 litters from 114 dams.

Statistical analysis

Estimation for genetic parameters was performed by bi-trait model using VCE-5. The statistical models for WW, W60, BFT60 and LEA60 are as follows:

$$y_i = Xb_i + Za_i + Sc_i + e_i$$

where $\boldsymbol{y}_i$ is a vector of observations, $\boldsymbol{b}_i$ is a vector of fixed effects including a contemporary group, sex effect (except in WW), parity effect and covariate including weaning age for only WW. For the *i*th trait, $\boldsymbol{a}_i$ is a vector of random animal effects, $\boldsymbol{c}_i$ is a vector of random common environmental effects and $\boldsymbol{e}_i$ is a vector of random errors; **X**, **Z**, and **S** are incidence matrices relating records.

The statistical models for AGF, BFTF, LEAF and carcass traits are as follows:

$$y_i = Xb_i + Za_i + e_i$$

where $\boldsymbol{y}_i$ is a vector of observations, $\boldsymbol{b}_i$ is a vector of fixed effects including a contemporary group, sex effect, and covariate including age at finish or body weight at finish for, $\boldsymbol{a}_i$ is a vector of random animal effects, and $\boldsymbol{e}_i$ is a vector of random errors; **X**, and **Z** are incidence matrices relating records.

A management group was defined as a contemporary group according to year and season of birth (spring: March to May; summer: June to August; autumn: September to November; and winter: December to February).

The statistical models for TWB, TWW, TNB, and TNW are as follows:

$$y_i = Xb_i + Za_i + Sp_i + e_i$$

where $\boldsymbol{y}_i$ is a vector of observations for the *i*th trait, $\boldsymbol{b}_i$ is a vector of fixed effects including a contemporary group by serviced year and season and covariate including parity, weaning age, and litter size at birth or weaning, $\boldsymbol{a}_i$ is a vector of random animal effects, $\boldsymbol{p}_i$ is a vector of random permanent environmental effects and $\boldsymbol{e}_i$ is a vector of random errors; **X**, **Z**, and **S** are incidence matrices relating records.

【Results and discussion】

Table 1. Estimate of heritabilities (h^2±SE), permanent environmental effect (p^2±SE) for reproductive traits.

Traits[1]	N	Means	S.D.	C.V.	h^2	p^2
TWB	564	11.33	3.50	0.31	0.14±0.04	0.03±0.02
TNB	564	9.25	2.86	0.31	0.12±0.05	0.03±0.03
TWW	553	48.75	15.86	0.33	0.13±0.04	0.06±0.04
TNW	564	7.26	2.58	0.36	0.11±0.03	0.00±0.00

[1]TWB: Total weight of piglets born alive per litter; TNB: Total number of piglets born per litter; TWW: Total weight of piglets at weaning per litter; TNW: Total number of piglets at weaning per litter.

Table 2. Estimates of genetic correlations (±SE) between reproductive traits.

Traits[1]	TNB	TWW	TNW
TWB	0.64±0.13	0.51±0.12	0.65±0.12
TNB		0.10±0.47	0.77±0.33
TWW			0.93±0.05

[1]TWB: Total weight of piglets born alive per litter; TNB: Total number of piglets born per litter; TWW: Total weight of piglets at weaning per litter; TNW: Total number of piglets at weaning per litter.

Table 3. Estimates of genetic correlations (±SE) between reproductive and performance traits.

Traits[1]	WW	W60	BFT60	LEA60	AGF	LEAF	BFTF	TEAT
TWB	0.68 ±0.17	0.48 ±0.20	-0.02 ±0.21	0.60 ±0.19	-0.78 ±0.18	0.29 ±0.22	-0.06 ±0.23	0.17 ±0.14
TNB	-0.41 ±0.15	0.25 ±0.30	-0.14 ±0.42	-0.73 ±0.23	0.06 ±0.20	0.14 ±0.23	0.11 ±0.24	0.03 ±0.23
TWW	-	0.79 ±0.19	-0.10 ±0.31	-0.07 ±0.27	-0.38 ±0.14	0.36 ±0.17	-0.23 ±0.17	0.06 ±0.14
TNW	0.20 ±0.27	0.50 ±0.26	0.33 ±0.27	-0.36 ±0.21	-0.07 ±0.17	0.26 ±0.19	0.17 ±0.19	0.01 ±0.17

[1]WW: weaning weight; W60 = body weight at 60 d of age; BFT60 = backfat thickness at 60 d of age; LEA60 = loin eye area at 60 d of age; AGF = age at finish; BFTF = backfat thickness at finish; LEAF = loin eye area at finish; TEAT = number of teats; TWB: Total weight of piglets born alive per litter; TNB: Total number of piglets born per litter; TWW: Total weight of piglets at weaning per litter; TNW: Total number of piglets at weaning per litter.

Table 4. Estimates of genetic correlations (±SE) between reproductive and carcass traits.

Traits[1]	SCFB	SCFS	SCFL	SCFH	SCF10	LEAC
TWB	-0.55±0.29	-0.55±0.32	0.16±0.32	0.12±0.30	-0.08±0.29	0.06±0.13
TNB	0.11±0.38	0.00±0.44	1.00±0.00	-0.28±0.48	0.06±0.38	-0.50±0.51
TWW	-0.39±0.23	-0.55±0.24	0.12±0.27	-0.43±0.27	-0.30±0.22	0.38±0.22
TNW	-0.15±0.27	-0.05±0.30	0.76±0.27	-0.41±0.37	-0.17±0.29	-0.35±0.26

[1]SCFB = subcutaneous fat thickness on back; SCFS = subcutaneous fat thickness on shoulder; SCFL = subcutaneous fat thickness on loin; SCFH = subcutaneous fat thickness at 1/2 on carcass length; SCF10 = subcutaneous fat thickness on between 10th and 11th rib, LEAC = loin eye area on carcass; TWB: Total weight of piglets born alive per litter; TNB: Total number of piglets born per litter; TWW: Total weight of piglets at weaning per litter; TNW: Total number of piglets at weaning per litter.

Table 1 shows number of observations, means, S.D., C.V., estimated heritabilities and permanent environmental effects for the reproductive traits. The estimates of heritabilities and permanent environmental effect were all low.

Table 2 shows estimates of genetic correlations between reproductive traits. Within traits of sows, genetic correlations for TWB and TWW with TNB and weaning TNW were positively moderate to high.

Table 3 and table 4 show estimates of genetic correlations between reproductive and performance traits and estimates of genetic correlations between reproductive and carcass traits, respectively. Genetic correlations of TWB and TWW with WW, W60 and AGF on growth traits showed favorable estimates. Genetic correlations of TWB and TWW with LEAC and some SCF on carcass traits also showed favorable estimates. Whereas genetic correlations of TNB and TNW with growth and carcass traits were unfavorable. These results indicated that TWB and TWW should be chosen for improving reproductive performance of sows. The genetic correlations of TEAT with TWB, TNB, TWW and TNW were slightly positive. Thus TEAT was independent with the litter traits of sows.

【Conclusion】

- Genetic relationships of a litter weight at birth and at weaning with weaning weight, body weight at 60 days of age and age at 105kg on growth traits are favorable for improvement.
- Genetic relationships of a litter weight at birth and at weaning with loin eye area and some subcutaneous fat thickness on carcass traits also showed favorable estimates.
- From above the results, comparing within reproductive traits, a litter weight at birth and at weaning should be chosen for improving reproductive performance of sows.