# GENETIC PARAMETERS FOR REPRODUCTION TRAITS IN SOWS OF LINES SELECTED FOR GROWTH RATE ON RESTRICTED FEEDING

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## SUMMARY

Genetic parameters for litter traits: total number born (TNB), number born alive (NBA), average piglet birth weight (ABW) and number of piglets weaned (NW), and for sow traits: mating weight (MW), gestation length (GL) and daily food intake of lactating sows (DFI), were estimated on 913 litter records through the restricted maximum likelihood method using an animal model. Estimates of heritability for most of the traits except for ABW (0.33) and MW (0.32) were low, around 0.10. Genetic correlations of TNB and NBA were positive with NW (0.26 and 0.43) and negative with ABW (−0.13 and −0.11). A combined selection for litter size and birth weight is expected to result in higher number of healthy piglets with high potential for post-natal growth. TNB and NBA showed positive genetic correlations with DFI (0.12 to 0.19) but negative correlations with MW and GL (−0.03 to −0.27). Genetic associations of NW with MW and GL or DFI were also negative and positive, respectively.

**Keywords**: Genetic parameters, selection, correlated responses, pigs.

## INTRODUCTION

Correlated responses in the reproductive performance of Large White pigs selected for high and low growth rate under restricted feeding regime were reported by Nguyen (2002). With an aim of making a quantitative assessment of the efficiency of the selection strategy, genetic parameters for reproduction traits were also estimated in this study. Knowledge of these is necessary for developing efficient, long-term improvement schemes for these traits. Reports on the genetic relationships between litter traits and traits recorded on the sow (e.g. between litter records and lactation food intake) have been limited in the literature, and it is difficult to incorporate these traits effectively into breeding programs.

The aim of the present study is to report genetic parameters for both litter and sow traits in lines selected over four years for high and for low post-weaning growth rate on restricted feeding.

## MATERIALS AND METHODS

**The genetic selection lines and measurements.** Data were collected from four years of selection of Large White pigs for high and low post-weaning growth rate on restricted feeding. Briefly, two lines of Large White pigs were formed by within-litter sampling from an outbred herd. One line was selected for high growth rate and one selected for low growth rate. At 50 kg live weight, pigs from the high and low growth rate lines were sampled across litters, placed in groups of six and fed in individual stalls a fixed but restricted ration of approximately 80% of *ad libitum* feeding over 6 weeks. At the end of the six-week testing period, boars and gilts tested in each of the selection lines

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Breeder replacements were then transferred to the dry sow building and penned in groups of 3 or 4 and fed a commercial diet of 13.7 MJ DE/ kg, 180 g CP/ kg and 0.37 g available lysine per MJ DE until about 8-10 months of age when they were first mated. Mating partners were chosen within each line. Full and half-sib mating were avoided with the aim of minimising inbreeding. Conception was assumed when no signs of behavioural oestrus were observed at 21 days post-mating. During gestation, pregnant sows were fed 2.5 kg daily a ration containing 15 MJ DE/ kg, 173 g CP/ kg DE, and 0.37 g available lysine/ MJ DE. The level of feeding was slightly increased in the later stages of pregnancy in order to prevent losses of maternal body stores, and also to encourage growth of the foetus.

Approximately 4 to 7 days before their expected farrowing dates, sows were transferred to single pens in the farrowing / weaner building where they were farrowed in batches of 24 (12 per line) with an interval of 6.5 weeks between batches. Parturition usually occurred after 115 days of pregnancy and was monitored closely. Lactating sows were fed *ad libitum* on a 14 MJ DE and 0.55 g lysine per MJ DE diet. Feed intakes were measured from 7 days to 35 days after farrowing. During suckling, piglets were provided with a high quality commercial creep diet of 15 MJ DE/ kg and 0.75 g available lysine per MJ DE and an electrolyte replacer until weaning. The creep diet was rich in calcium (8.0 g/kg) and phosphorus (6.0 g/kg). Within 7 days of farrowing, cross-fostering was practiced to a limited degree between sows of the same line.

Measurements for reproductive traits include total number born (TNB), number born alive (NBA), average piglet birth weight (ABW), number of piglets at weaning (NW), body weight of sows prior to mating (MW), gestation length and daily food intake during lactation (DFI).

**Statistical analysis.** Analyses were performed on 993 litter records, with 75 sires and 180 dams. The significance of the fixed-effects terms was determined using the general linear model. Preliminary REML analysis using the ratio of variance components to standard errors or the likelihood ratio test showed that either maternal genetic or common litter effects were not significant (Gilmour et al. 1999). The outcome was that only the additive genetic random effect of the animal was fitted in the model for both univariate and multivariate analyses, with the fixed effects of batch (29 classes) and parity (5 classes). Weaning age was fitted as a linear covariate for individual weaning weight and the number of suckling pigs for daily food intake of sows and mating age for mating weight of sows.

## RESULTS AND DISCUSSION

**Heritabilities.** The estimates of heritability for litter traits in the present study (Table 1) were consistent with others in the literature (Rothschild and Bidanel 1998). Information on genetic variances for gilt and sow traits is limited in the literature. The heritability for body weight of sows prior to mating was moderate (0.32) in this study and was biased upward (0.40) if mating ages of sows were not fitted as a linear covariate in the genetic model of analysis. Documented estimates for age at puberty range from 0.00 to 0.64, with the mean of 0.33 (Rothschild and Bidanel 1998). The present estimate of heritability for gestation length was in a good agreement with the range from 0.22 to 0.26 in British Large White (Crump et al. 1997) and Dutch Landrace (Hanenberg et al. 2001). The low heritability of 0.12 indicated that voluntary food intake of lactating sows would be difficult to change by direct selection.

**Table 1. Animal model multivariate analyses of heritabilities (bold), phenotypic (above) and genetic (below the diagonal) correlations between sow and litter traits (s.e. in italics)**

| Traits | TNB | NBA | ABW | NW | MW | GL | DFI |
|---|---|---|---|---|---|---|---|
| TNB | **0.11** | 0.88 | -0.40 | 0.23 | 0.10 | -0.06 | 0.02 |
| | ***0.04*** | *0.00* | *0.04* | *0.04* | *0.04* | *0.04* | *0.04* |
| NBA | 0.90 | **0.07** | -0.35 | 0.32 | 0.10 | -0.09 | 0.02 |
| | *0.06* | ***0.04*** | *0.04* | *0.04* | *0.04* | *0.04* | *0.04* |
| ABW | -0.13 | -0.11 | **0.33** | -0.01 | 0.05 | -0.01 | 0.11 |
| | *0.21* | *0.25* | ***0.05*** | *0.04* | *0.03* | *0.04* | *0.04* |
| NW | 0.26 | 0.43 | 0.27 | **0.13** | -0.08 | 0.05 | 0.11 |
| | *0.27* | *0.28* | *0.20* | ***0.04*** | *0.04* | *0.05* | *0.04* |
| MW | -0.07 | -0.18 | 0.03 | -0.60 | **0.32** | 0.05 | 0.04 |
| | *0.19* | *0.24* | *0.13* | *0.18* | ***0.05*** | *0.05* | *0.04* |
| GL | -0.17 | -0.27 | 0.08 | 0.34 | 0.07 | **0.24** | 0.02 |
| | *0.21* | *0.24* | *0.15* | *0.20* | *0.14* | ***0.05*** | *0.04* |
| DFI | 0.19 | 0.12 | 0.18 | 0.27 | 0.13 | 0.10 | **0.12** |
| | *0.26* | *0.30* | *0.19* | *0.25* | *0.18* | *0.21* | ***0.04*** |

**Genetic correlations between reproductive traits.** The moderate, negative genetic correlations of TNB and NBA with ABW in the present study indicated that direct selection for increased litter sizes results in a decrease in piglet birth weight, and therefore leads to increased pre-weaning mortality and reduced post-natal growth of piglets. Regression analysis also showed that piglet birth weight decreased by 0.026 kg for an extra piglet in litter size (Nguyen, 2002). The negative relationship between litter size at birth and piglet weight also implies the existence of constraints on pre-natal growth of piglets, such as increased competition among embryos/foetuses for uterine resources (Christenson et al. 1987). There was no evidence of an upper limit to uterine capacity because litter size at birth ranged from three to 21 piglets. Here, the magnitudes of the genetic correlations of TNB and NBA with NW, although moderate and positive, were somewhat lower than the earlier reported results (e.g. Kerr and Cameron 1995; Hermesch et al., 2000), indicating that environmental factors strongly impact on pre-weaning mortality of piglets. In summary, direct selection for high prolificacy traits should prevent a decrease in piglet birth weight as a result of the moderate, positive genetic correlation between ABW and NW (0.27). As a result breeding objective traits for reproduction therefore should be defined as weight of pork per sow per year rather than simply number of piglets born alive to enforce this positive relationship.

The genetic correlations between litter sizes (TNB and NBA) and MW in the present study were negative, but not significantly different from zero. It has been implied that genetically fat sows would produce fewer ova and had lower ovulation rate and embryo survival, resulting in a reduced litter size at birth (Bidanel et al. 1996). The genetic correlation between NW and MW was high and negative (–0.60), suggesting that the body reserves of sows are more depleted when litter size at weaning is high. Gestation length may be shortened if litter sizes are increased, indicated through the genetic correlations estimates of –0.17 to –0.27. A similar result was also reported recently in Dutch Landrace (Hanenberg et al. 2001).

The energy intake of lactating sows must be sufficient to meet any extra requirement in response to increases in numbers and weights of piglets at birth and at weaning. The genetic correlations between litter traits and daily food intake of the lactating sows were all positive and moderate (0.19 to 0.30) in the present study. A reduced food intake of sows during lactation would increase body weight and fat losses, which may have detrimental effects on post-natal growth rate and survival of the piglets.

It is concluded that most reproductive traits are hardly improved by selection due to their low heritabilities. Breeding for high litter size should limit a decrease in piglet birth weight. The genetic correlations of litter sizes at birth and at weaning with mating weight and lactation daily food intake indicate that energy requirement of sows during lactation needs to be met to compensate for weight and fat losses.

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