# Genetics of Teat Quantity and Quality in Norwegian Landrace

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## Introduction

During the last 20 years there has been substantial improvement in prolificacy (number born alive/litter) in swine for a number of countries and breeding organizations. Admittedly, there have been improvements in husbandry (nutrition, vaccines and sow care, for example), but most breeding organizations have had a function of litter size as a major component in their breeding objectives for maternal lines. With increased prolificacy, a constraint can arise with the number and quality of functional mammary glands available on a sow to: 1) provide the needed initial colostrum to all pigs in the litter, and 2) provide nutrition to the litter during the lactation period. A number of studies (Pumfrey, R.A., R.K. Johnson, P.J. Cunningham et al., 1980; Clayton, G.A., J.C. Powell, and P.G. Hiley, 1981; Smith, P.R., C.P. McPhee, and W.J. Natoli, 1986; McKay and Rahnefeld, 1990; Sellers, 1994; Nicholas, 1998; Drickamer, L.C., T.L. Rosenthal and R.D. Arthur, 1999) have examined the inheritance of teat number and these ranged between 10-20%. Most current breeding programs record teat number for use in the breeding objective for boar and gilt selection in maternal lines. Norsvin has included total number of teats in their aggregate breeding value since 2001, and, during the last 4 years, have seen genetic progress of 0.6 teats in the Landrace line (unpublished data). Some organizations also record teat quality (number of inverted and/or abnormal teats) in their programs, and Wold (2009), in a study with Norwegian Landrace, found the vast majority of abnormal teats were inverted teats. Clayton et al. (1981) investigated the heritability of inverted teats and found this similar to levels mentioned above. They recommended boars with severe inversions (one or more teats where the nipple is not visible) should be culled but also noted “More evidence on the expression of this trait in boars is required”. Boars do not have functional teats, and inverted teats on boars may not indicate they will have daughters with a larger number of inverted teats. It has been observed that teat quality in boars was “an artifact of male anatomy” (especially teats around the sheath), and some boars can get abrasions on their teats during aggressive mounting in growing pens, that, when healed, appear to be inverted due to scar tissue build up (Dr Billy Flowers, *per comm*.). This questions the practice of assessing boar selection candidates for teat quality. Also, with an increase in teat number, will there be an increase in the number of inverted teats in gilts and sows? The current study was undertaken to investigate the genetic relationships between teat number and teat quality in boars and gilts to further refine selection decisions needed to improve these traits in highly prolific maternal lines.

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## Materials and Methods

Data for this study came from Norwegian Landrace in Norsvin nucleus herds, daughter nucleus herds and boar testing facilities in Europe and the US. The genetic linkage was very good between European and US herds since all nucleus herd matings were done with semen from the same boars in Norway. Teat counting was done on boars and gilts at three weeks of age by farm staff. Teat quality assessments were performed at off test on gilts, as they stood in the scanning crate, when animals weighed approximately 100 kg. Teat quality assessments on boars were done as boars slept during CT-scanning at the Norsvin boar testing facility. Pre-selection occurred for boars going into the testing facility, so boars with less than 14 teats or poor underline quality were not included in the data set. Traits analyzed were: total number of teats on boars (NOTB), total number of teats on gilts (NOTG), number of inverted teats on boars (NOINB) and number of inverted teats on gilts (NOING). There were data from 5817 boars and 36,639 gilts used in this study, and the pedigree file used in the analyses went back 12 generations. Average values, standard deviations, minima and maxima are presented in Table 1.

**Table 1: Numbers of animals per trait, means, standard deviations, minima and maxima**

| | N | Means | SD | Minimum | Maximum |
|---|---|---|---|---|---|
| NOINB | 5817 | 0.68 | 1.80 | 0 | 16 |
| NOING | 36639 | 0.77 | 2.02 | 0 | 17 |
| NOTB | 5817 | 15.54 | 0.96 | 12 | 20 |
| NOTG | 36639 | 15.41 | 1.01 | 10 | 20 |

Estimation of (co)variance components was done using multi-trait animal models, employing restricted maximum likelihood (REML) methodology. Effects in the model included year*season and herd*season as fixed effects and common litter and animal as random effects. Levels of the fixed effects are presented in Table 2. The DMU 6.7 software package (Madsen and Jensen, 2008) and the average information (AI) algorithm were used in this study. Asymptotic standard errors of (co)variance components were computed from the inverse average information matrix.

**Table 2: Effects included in the model for each trait and the number of levels for fixed effects**

| | Fixed effects | | Random effects | |
|---|---|---|---|---|
| | Year*season | Herd*year | Common environment, litter | Animal |
| NOINB | 9 | 139 | # | # |
| NOING | 9 | 350 | # | # |
| NOTB | 9 | 139 | # | # |
| NOTG | 9 | 350 | # | # |

## Results and Discussion

Results from this study are presented in Table 3. The heritabilities for the four traits analyzed were medium range heritabilities with the heritability for inverted teats in boars being the lowest. Boars were pre-selected before going into the test facility, and boars with less than 14 teats or poor underline quality were excluded from consideration for testing. This pre-selection may have contributed to the lower heritability for number of inverted teats in boars. The genetic correlation between total number of teats in gilts and total number of teats in boars indicate these are the same trait in these two sexes. Genetic correlations between total number of teats and number of inverted teats were unfavorable for both sexes. Although the heritability for number of inverted teats in boars was lower than other estimates in this study, there was a relatively high genetic correlation between number of inverted teats in boars and gilts.

**Table 3: Estimates of genetic parameters in the Norwegian Landrace population**[α]

| | NOINB | NOING | NOTB | NOTG |
|---|---|---|---|---|
| NOINB | 0.21±0.03 | 0.70±0.07 | 0.38±0.08 | 0.37±0.07 |
| NOING | N.E | 0.32±0.02 | 0.13±0.06 | 0.11±0.04 |
| NOTB | 0.094** | N.E. | 0.38±0.03 | 0.99±0.01 |
| NOTG | N.E | -0.01** | N.E. | 0.41±0.02 |

[α]Heritability ± s.e. on the diagonal, phenotypic correlations ± s.e. below and genetic correlations ± s.e. above the diagonal.** Phenotypic correlations significantly different from zero, p=0.01. N.E. – Not estimable.

Results from this study indicate teat number on boars and gilts should continue to be recorded and included in the breeding objective for maternal lines, especially when these lines are highly prolific lines. These results also suggest single trait selection for increased teat number could increase the number of inverted teats, as a correlated trait. If the ultimate goal is to increase the number and quality of functional mammary glands for the lactating sow, both teat number and teat quality, as measured by the number of inverted teats, should be included in recording schemes and the breeding objective for maternal lines. Given the heritabilities in this study, information from all relatives should be included in the genetic analyses and thereby in the selection process to further refine selection decisions. Phenotypic selection alone (independent culling levels, for example) will not be adequate to make improvements in these traits. Independent culling could also lead to some selection candidates with high aggregate breeding value, based on other economically important traits, to not be selected due to having one inverted teat. Such a regime will be inefficient and lead to less genetic improvement for all traits. These traits should be included in the breeding goal and weighed appropriately with other important traits in the breeding objective to enhance optimal genetic progress.

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