Using Testis Size in Boars as an Indicator Trait for Farrowing Performance in Sows

A.S. Leaflet R3342

Leticia P. Sanglard, Ph.D. student, ISU;
Richard J. Leach, Senior Geneticist, Fast Genetics, Iowa
Nick V. L. Serão, Assistant Professor,
Iowa State University.

Summary and Implications

Genetic improvement of reproductive traits is challenging due to their low heritability. The identification of an alternative trait that is correlated with reproductive traits and is highly heritable could be used as a selection tool to improve reproductive efficiency in pigs. In this study, we observed that testis size is highly heritable and that the daughters of sires with larger testis size have greater litter size. Selection of sires with adequate testis size may improve reproductive efficiency in the swine industry.

Introduction

Reproductive ability is associated with the increase of the overall efficiency of swine production. Genetic improvement of reproductive traits can be slow because of their low heritability (h^2). Thus, the identification of an indicator trait with high h^2 and genetic correlation with reproductive performance could be used to increase genetic progress for reproductive traits. Testicular development and ovarian activity in females have the same hormonal control and are affected by the same autosomal genes, suggesting that the use of testis size to improve female reproductive ability should be investigated. Therefore, we proposed to investigate the relationship between testis size in boars and farrowing performance of their daughters.

Materials and Methods

During the period of November 2015 and February 2018, a total of 384 (300 Landrace and 84 Yorkshire) sows were recorded for reproductive traits: total number born (TNB), number born alive (NBA), alive after 48h (alive48), total born dead (TBD), dead within 48h (dead48), stillborn, and mummies. Parities ranged from 1 to 7. 161 boars (97 Landrace and 64 Yorkshire) were measured for testis width (TW; in cm) at 157 ± 6.8 days of age and 112.8 ± 13.3 kg of weight, and testis area (TA; in cm^2) was calculated based on the formula TA = TW * Testis Height. The 384 sows were daughters of 13 of the 161 boars. The pedigree file contained 7,432 animals from 14 generations. Genetic parameters (h^2 and genetic correlation - r_G) for testis size traits (TA or TW) and for reproductive performance were estimated. To assess the relationship between testis size traits of boars and farrowing performance of their progeny, a Poisson regression of the reproductive traits of the 384 daughters on the testis size of their 13 sires was performed.

Results and Discussion

In general, the h^2 and repeatability estimates of reproductive traits were low to moderate indicating that the direct response may be limited in genetic selection for these traits and the reproductive performance of each parity does not predict successive parities. These ranged from 0.01 (mummies) to 0.18 (dead48) for h2 and 0.01 (mummies) to 0.20 (TNB) for repeatability. In contrast, the h^2 estimates of TA and TW were much greater, with 0.69 ± 0.22 and 0.66 ± 0.21, respectively.

Results of the relationship between testis size in boars and farrowing performance in their progeny are presented in Table 1 and Figure 1. The phenotypic analyses showed quadratic ($P < 0.05$) and linear ($P < 0.02$) relationships between reproductive traits in sows with TA and TW in boars, respectively. For each linear cm^2 increased in TA, we would expect an increase of 1.7, 1.5, and 1.3 times in TNB, NBA, and alive48, respectively. The greatest TNB, NBA, and alive48 were obtained for TA within 17.2 to 18.5 cm^2, which did not overlap with the TA range that resulted in greater TBD, mummies, and stillborn (15.8 to 16.3 cm^2). In addition, an increase in TW was associated with an increase in a number of the survival traits ($P < 0.02$) and did not affect the mortality traits ($P > 0.11$). For each cm increased in the TW, there was an increase of 1.1, 1.2, and 1.2 times in TNB, NBA, and alive48. The higher effect of TW on the alive48 seems very interesting since we have shown previously that alive48 may be the most effective trait for selecting for survival traits without increasing the mortality traits. In addition, the range of TW analyzed did not reach the potential maximum number of reproductive traits, which may indicate that there is an opportunity for continuously increasing survival traits when increasing TW.

Therefore, evaluation of testis size seems to be a good tool to select boars that generate daughters with better reproductive performance. These findings raise the possibility of using testis size for obtaining indirect earlier selection in female reproductive performance.

Acknowledgments

The authors would like to thank the staff responsible for collecting the data and Iowa State University for funding.

Table 1. Effect of testis size on reproductive traits in sows

Reproductive trait[1]	Effect[2]		
	TA	TA^2	TW
TNB	0.51*	-0.01*	0.12*
NBA	0.41*	-0.01*	0.16*
alive48	0.30*	-0.008*	0.20*
TBD	1.40*	-0.04*	-0.37
stillborn	1.74*	-0.05*	-0.36
dead48	2.66*	-0.08*	-0.27
mummies	0.51	0.02	-0.41

TA = linear effect of testis area (cm^2); TA^2 = quadratic effect of TA; TW = linear effect of testis width (cm);
[1]TNB = total number born; NBA = number born alive; alive48 = alive for 48h; TBD = total born dead; dead48 = death with 48h;
[2]Rate ratio in log scale equivalent to a one unit difference in the corresponding predictor
*Significant effect at level of significance $\alpha = 0.05$.

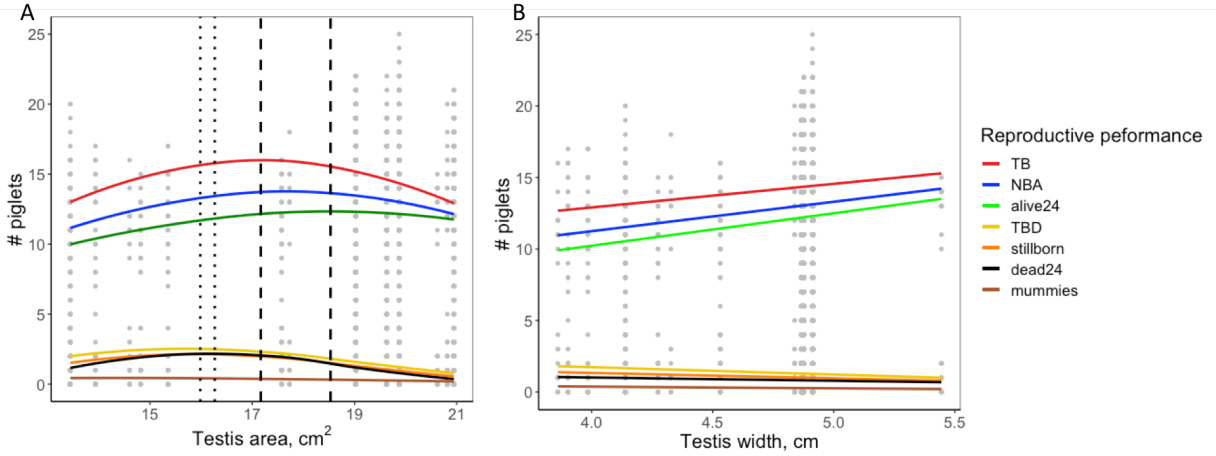

Figure 1. Relationship between testis size of sires with reproductive performance of daughters. Lines represented the fitted curve. Figures A and B represent associations of testis area and width, respectively, with total born (TNB; red line), number born alive (NBA; blue line), alive after 48h (alive48; green line), total born dead (TBD; yellow line), stillborn (orange line), dead within 48h (dead48; black line), and mummies (brown line). The x-axis represents the testis area (A) in cm2, and testis width (B) in cm. The y-axis represents the number of piglets. The grey dots represent the actual number of piglets corresponding to all plotted reproductive traits. The vertical dotted and dashed line represent the range of testis area which would give higher mortality and higher number of the alive reproductive traits, respectively.